SECTION VII

ELECTROSTATIC DISCHARGE CONTROL

7-1. GENERAL.

a. Purpose. The primary purpose of this section is to describe electrostatic discharge (ESD) control measures which shall be employed to minimize the impact of ESD damage to electrical and electronic parts, assemblies and equipment. This section explains measures to be taken by all personnel that handle ESD Sensitive (ESDS) items which will prevent ESD damage to electronic parts, assemblies, and equipment.

b. Scope. Discussed in this section is a summary of ESD principles, the nature of the damage it does to electronic devices, and a summary of ESD susceptibility of electronic parts, assemblies and systems. In addition this section covers the framework of ESD control, a summary of required ESD Control procedures for the protection of ESD-sensitive (ESDS) items, descriptions of ESD Control equipment with corresponding stock numbers and specifications, grounding procedures and work area ESD Control survey requirements.

c. Applicability. Section VII applies to and governs the operating procedures of all personnel who handle, inspect, repair, test, operate and maintain items susceptible to damage from ESD. Questions pertaining to the requirements of this section can be directed to the Air Force ESD Control Technology Center at Newark AFB, Ohio at DSN 346-7383.

7-2. REFERENCES.

The following specifications, standards and handbooks are referenced in this section.

MIL-STD-129	Marking for Shipment and Storage
MIL-STD-1686	ESD Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment
MIL-STD-454	General Requirements for Electronic Equipment
MIL-HDBK-263	Handbook for Protection of Electrical and Electronic Parts, Assemblies, and Equipment
MIL-W-87893	Workstation, Electrostatic Discharge (ESD) Control
MIL-B-81705	Barrier Materials, Flexible, Electrostatic Protective, Heat Sealable
MIL-STD-1285	Marking of Electrical and Electronic Parts
MIL-P-81997	Pouches, Cushioned, Flexible, Electrostatic-Free Reclosable, Transparent
MIL-B-117	Bags, Sleeves and Tubing
MIL-STD-883	Test Methods and Procedures for Microelectronics
ASTM F-150	Standard Test Method for Electrical Resistance of Conductive Resilient Flooring
PPP-C-1842	Cushioning Material, Plastic, Open Cell (For Packaging Applications)
PPP-C-795	Cushioning Material, Flexible, Cellular, Plastic Film for Packaging Applications
PPP-B-1672	Boxes, Shipping, Reusable with Cushioning
PPP-C-1752	Cushioning Material, Packaging, Unicellular, Polyethylene Foam, Flexible
PPP-C-1797	Cushioning Material, Resilient, Low Density, Unicellular, Polyethylene Foam
QML-38535	Qualified Manufacturers List of Advanced Microcircuits
QPL-19500	Qualified Products List for MIL-S-19500 Semiconductor Devices
National Electrical Code (NEC)	

These documents are not directive in nature; therefore, they do not mandate procedures. They do, however, contain detailed information which is needed to carry out ESD control requirements levied per this technical order (TO). Note that the most current revision of the referenced standards, handbooks and specifications will be used. In the event of inconsistencies between this technical order and the referenced standards and handbooks, this technical order will take precedence.

7-3. SUMMARY OF ESD PRINCIPLES.

a. Static Electricity. Static electricity is an electrical charge at rest. The electrical charge is due to the transfer of electrons within a body or from one body to another. The magnitude of the charge is dependent on the size, shape, composition, and electrical properties of the substances which make up the bodies. The electrical charge can be changed when two substances are rubbed together, separated or flow relative to one another (i.e. one substance gains electrons and the other loses electrons). The charges on these two substances are equal and opposite, and in the case of non-conductors tend to remain in the localized

area of contact for relatively long periods of time. Charges generated on conductors are rapidly distributed over their surfaces.

b. Sources of Static Electricity. Personnel shall be aware of materials and activities which pose hazards as sources of static electricity in the work place. Typical prime charge sources or static generators commonly encountered in the work place are listed in Table 7-1. Most of the items listed are non-conductors (insulators) and are typically synthetic materials. Electrostatic voltage levels generated by insulators can be very high since the charge generated is not distributed over its entire surface. Ungrounded conductors may also generate substantial static levels. Table 7-2 shows typical electrostatic voltage levels generated by personnel.

Table 7-1. Typical Sources of Static Electricity

Object or Process	Material or Activity
Work Surfaces	Waxed, painted or varnished surfaces Common vinyl or plastics Finished wood
Floors	Sealed concrete Waxed, finished wood Common vinyl tile or sheeting High pressure laminates made from insulative materials Carpeted surfaces
Clothes	Common synthetic clean room smocks Common synthetic personnel garments Non-conductive or synthetic shoe soles Virgin cotton (See Note below)
Chairs	Finished Wood Vinyl, plastic Fiberglass Synthetic Fabric
Packaging and Handling	Paper Products Common plastic connector caps or plugs Common plastic - bags, wraps, envelopes Common plastic bubble pack, foam Common plastic trays, tote boxes, vials, parts bins Sufficiently aged anti-static treated bags, wraps, envelopes Tapes, tape dispensers, stickers
Assembly, Cleaning, Test and Repair Areas	Polyethylene bags, pouches Spray cleaners Common plastic solder suckers Solder irons or guns with ungrounded tips Solvent brushes (synthetic bristles) Cleaning with high resistance fluids Drying, vacuuming or spraying using nozzles made of plastic Cryogenic sprays Heat guns and blowers Sand or bead blasting Electrostatic copiers Plastics tool handles, tool boxes, work folders, laminated papers Plastic syringes, ballpoint pens, insulative support blocks

Table 7-1. Typical Sources of Static Electricity - Continued

Object or Process	Material or Activity
	Plexiglas and styrofoam materials Latex finger cots Paper products

NOTE: Virgin cotton can be a static source at low relative humidities such as below 30 percent.

Table 7-2. Typical Electrostatic Voltages Generated by Personnel

Means of static generation	Electrostatic Voltages
	10 to 20 percent relative humidity
Walking across carpet	35,000
Walking over vinyl floor	12,000
Worker moving at bench	6,000
Opening and closing vinyl envelopes used to carry work instructions	7,000
Common plastic bag picked up from bench	20,000
Worker sliding in work chair padded with polyurethane	18,000

c. ESD Parameters: The voltage potential achieved by human beings or materials is dependent on the total charge (Q) of the person or item, typically between .1 and 5 microcoulombs, and his/her material capacitance (C), typically between 100 and 250 picofarads. This voltage (V) is equal to the person's charge divided by the capacitance (V=Q/C). This voltage can reach levels as high as 35KV under the right conditions.

The discharge of this voltage potential (ESD) and the electrostatic field associated with this potential are what are considered detrimental to today's electrical and electronic devices. A discharge from human beings or materials to or through an electronic device can possess current values of 1-50A

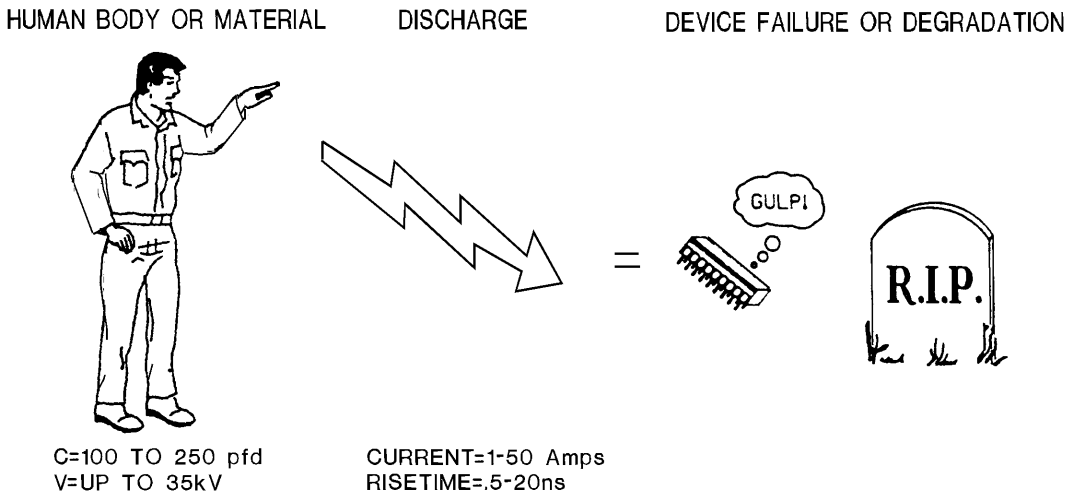

Figure 7-1. Reasons for Device Failure Due to ESD

and rise times of less than 20 nanoseconds. The energy associated with this discharge can be expressed in millijoules and most of today's circuits can only withstand a fraction of that amount. Figure 7-1 depicts the magnitude of ESD damage to sensitive electronic devices.

It is important to note that some of today's circuits are sensitive to voltages as low as 25 volts. The threshold of sensitivity or the level of voltage required for a human being to feel a static discharge is approximately 3500 volts. So damage can be done to devices by personnel without them knowing it.

d. Failure Mechanisms: ESD damage to electronic and electrical devices can be caused by voltage or current depending on the composition and construction of the device. This damage can be caused by direct contact or by the electrostatic field associated with charged items.

(1) Voltage-induced failures are predominate in metal oxide semiconductors (MOS) and film type resistors. Dielectric breakdown is the failure mechanism. Dielectric breakdown occurs when the threshold or maximum electric field strength of the dielectric medium is reached and bonded electrons within the medium break free and flow within the dielectric. Figure 7-2 illustrates dielectric failure in a 3N157 MOSFET due to a human body discharge of 4KV.

(2) Current-caused failures primarily affect bipolar devices (diodes, Schottky TTL, input protection circuits, op amps, etc). Thermal secondary breakdown and metallization melt are the mechanisms. Basically this means that the device cannot dissipate the power associated with an ESD event. The heat generated by the discharge melts device substructures.

The smaller the geometries of today's solid state devices the less energy it takes to destroy them.

e. Failure Types

(1) Catastrophic. ESD can cause total (catastrophic) failure of electronic parts, assemblies and equipment.

(2) Intermittent. ESD can cause intermittent failures or erroneous signals.

(3) Latent. Items already having been partially damaged by an ESD can check out electrically on the repair/test bench, but fail on the

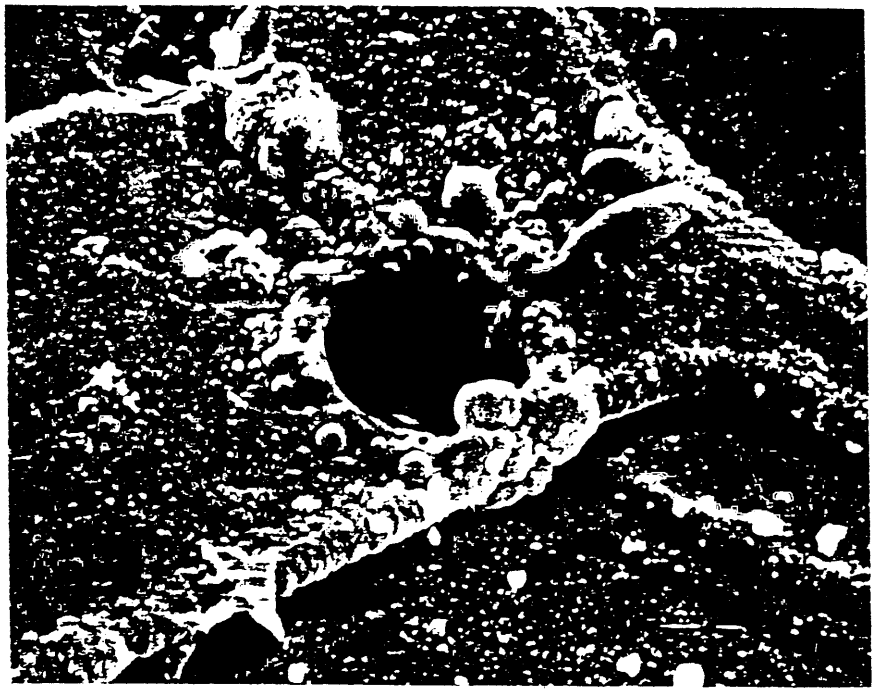

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Figure 7-2. Dielectric Failure in 3N157 MOSFET at 5000X

end item when subjected to stresses of wide temperature ranges, mechanical shock, high g-forces, landings or by applying normal operating voltages.

f. Common ESD Misconceptions: Typical misconceptions about ESD and control methods include:

(1) Higher humidity will solve the ESD problem.

Truth: Increasing humidity will only help. It would be more accurate to say that low humidity will aggravate existing ESD problems. (See paragraph (7-5.d.(9)).

(2) Components are safe from ESD once they are mounted on PC boards.

Truth: Surprisingly, they can be at least as sensitive to ESD damage. Components on the boards are still current and voltage sensitive even when the leads are attached to the board.

(3) If an electronics assembly passes final test, it means the components on it were handled properly.

Truth: Not necessarily true. The unit's field failure record, including intermittence, for one to two years after shipment may show the presence of intermittent and latent ESD-caused defects.

(4) The ESD issue can be resolved with the correct hardware and equipment.

Truth: ESD control hardware and equipment are useless without properly-trained people aware of the ESD hazard and understand how and why the hardware and equipment are used to prevent ESD damage.

7-4. ESD SUSCEPTIBILITY

a. Susceptible Items: Numerous discrete electronic parts, assemblies and equipment items are susceptible to ESD damage or degradation when an ESD event occurs or when exposed to electrostatic fields. The system program manager or equipment specialist for the item(s) in question shall utilize direction provided in paragraph 7-4.a.(1) to determine which items are ESD susceptible. A general discussion of what discrete parts and higher level assemblies are ESDS follows. The contents of the following paragraphs shall be used in the absence of other directives or determinations of ESDS items by the system program manager/equipment specialist as specified in paragraph 7-4.a.(1).

(1) Discrete Parts: The following discrete parts shall be considered ESDS. Note that the nomenclature given for each Federal Supply Class (FSC) specifies what items within the FSC are ESDS. Any exceptions to this guidance must be verified through actual testing conducted in accordance with MIL-STD-1686, Appendix A per test method 3015 of MIL-STD-883 and provided through the responsible system program manager or equipment specialist.

(a) All microcircuits and integrated circuits in FSC 5962

(b) Crystal Oscillators and Piezoelectric Crystals in FSC 5955

(c) Electronic Modules in FSC 5963

(d) Mini and Microcomputer Devices in FSC 7042

(e) Thick and thin film resistors, Resistor chips and resistor networks in FSC 5905. (Note: This does not include wire wound or carbon resistors)

(f) Any semiconductor device in FSC 5961 which includes diodes (PN, PIN, Schotty), metal oxide semiconductor field effect transistors (MOSFETS), junctions field effect transistors (JFETs), bipolar transistors, thyristors, input protection circuits on discrete MOSFETs and MOS ICs, semi-conductor devices operating at frequencies above 1 gigahertz.

(g) Very High Speed Integrated Circuits (VHSIC), SSI, MSI, LSI, VLSI and ULSI Integrated Circuits.

(h) Optoelectronic devices (LEDs, Phototransistors, Opto Couplers).

(i) Surface Acoustic Wave (SAW) devices.

(j) Operational Amplifiers (OP AMPs)

(2) Circuit boards, modules and assemblies. Any circuit board, wiring board, module or assembly containing discrete ESDS parts mentioned in paragraph 7-4.a.(1) above shall be considered ESDS.

(3) Any complete system, "Black Box ", Line Replaceable Unit (LRU), Shop Replaceable Unit (SRU), Electronic test or repair equipment console/item or end item containing the assemblies or parts mentioned in paragraphs 7-4.a.(1) and 7-4.a.(2) above shall be considered ESDS until the conditions of paragraph b. are satisfied.

b. When does ESD Susceptibility Stop: When the items listed in paragraph 7-4.a. are correctly packaged in accordance with paragraph 7-5.d.(12) they are no longer considered ESDS. That is, they are considered ESDS until the level of assembly or packaging is such that a complete electrostatic

shield (Faraday Cage) exists around the item or until which time it can be shown by testing that the ESDS item is protected from static voltages above 16,000 volts. A complete electrostatic shield, or Faraday Cage, is defined as, "An electrically continuous conductive enclosure which provides electrostatic shielding". For items in paragraphs 7-4.a.(1) and 7-4.a.(2) the "Faraday Cage" might be a closed or sealed static shielding pouch or conductive tote box. Regarding items listed in paragraph 7-4.a.(3), a complete electrostatic shield may be the chassis or outer case of the assembly (black box) with conductive caps or plugs applied to all electrical connectors.

c. Levels of ESD Sensitivity: Levels established for discrete electronic parts shall be limited to two categories: SENSITIVE and SUPERSENSITIVE. This is based on knowledge that certain technologies of parts are inherently sensitive to ESD and can fail at any voltage level between 0 and 16,000 volts. All discrete parts listed in paragraph 7-4.(1) shall be considered SENSITIVE to ESD between 0 and 16,000 volts. All assemblies and equipment specified in paragraphs 7-4.(2) and 7-4.(3) shall also be considered SENSITIVE to ESD between 0 and 16,000 volts.

Discrete electronic parts shall be considered SUPERSENSITIVE based on the technology and geometries of the devices involved or testing per MIL-STD-883 that has revealed voltage sensitivities of between 0 and 999 volts. Gate densities, metallization widths and dielectric thicknesses also contribute to a device being classified as SUPERSENSITIVE. Assemblies and equipment containing SUPERSENSITIVE devices shall also be considered SUPERSENSITIVE until which time the conditions of paragraph b. are met.

To determine the level of sensitivity of FSC 5961 parts, QPL-19500 can be used, and for FSC 5962 parts, QML-38535 can be used. These documents can be ordered through the Defence Electronic Supply Center (DESC), extension 513-296-5377 for QML-38535 and extension 513-296-6048 for QPL-19500.

Requirements for equipping work areas with ESD Control equipment or updating existing work areas that handle SENSITIVE parts, assemblies or equipment are based on the sensitivity of the most sensitive discrete part worked in the area. The final judgement as to the level of ESD Control(s) required shall be dictated by a work area ESD Control survey as done in conjuction with paragraph 7-7 of this technical order (TO).

Note that in the remainder of this section of the TO discrete electronic parts, assemblies and equipment items will be collectively referred to as "items".

7-5. FRAMEWORK OF ESD CONTROL

a. Work Area ESD Control Surveys:ESD Control work area surveys shall be conducted in accordance with this TO of all areas that handle ESDS items. What constitutes a work area shall be determined by the surveyor. It may be defined by the operations being performed, location, etc. The survey establishes the extent of ESD Controls required in each work area. A written report shall be completed after each work area survey to provide a record of the controls required in the work area.

b. ESD Control Strategies: Two simple rules will substantially reduce the risk of ESD damage to ESDS items.

(1) Rule 1: Handle all ESDS items at an approved static control workstation. ESDS items shall always be handled at a static control workstation or a personnel wrist strap utilized in situations where complete workstations are not feasible (i.e. on aircraft or missile maintenance) as described in paragraph 7-5.d.(1). Paragraph 7-7 provides guidance on the selection of a proper static control workstation or personnel wrist strap.

(2) Rule 2: Transport and store all ESDS items (both reparable and serviceable) in static shielding and non-charge generating packages or containers. These packages or containers are capable of protecting the inner contents against static fields and discharges. They are also constructed so that the interior surface contacting the packaged item is resistant to the generation of static charge. Paragraph 7-7 provides requirements for selection of the proper package or container for in-house and off-base transportation applications. Both reparable and serviceable ESDS items require protective packaging. Reparables require it to prevent further ESD damage from being done to the remaining operative parts. Paragraph 7-5.d.(12) provides the requirements of ESD protective packaging materials.

c. Conductive/Static Dissipative/Anti-Static Materials. For the purpose of ESD control, most protective materials will be either conductive or static dissipative. Packaging materials or containers used for ESD Control are typically as conductive [1 to 9.99×10^5 (999,999) ohms] as possible so that the best "Faraday Cage" properties are obtained. Static Dissipative materials [1.0x106 (1,000,000) to 1.0×10^9 (1,000,000,000) ohms]) are

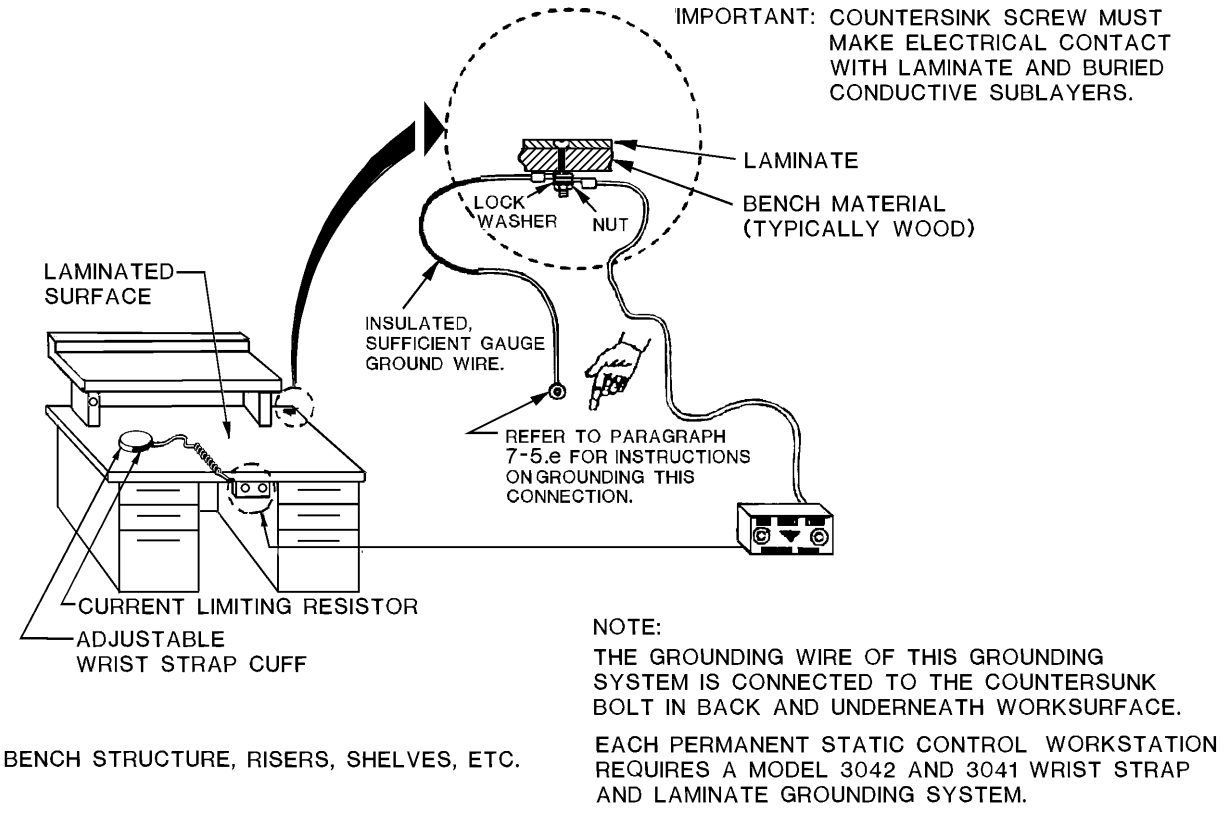


Figure 7-3. Permanent Static Control Workstation

used for all other products (i.e. work surfaces, garments, footwear, flooring, etc.) so that adequate static drain is accomplished. That is, static drain that is fast enough to remove static charge quickly yet slow enough as to not produce damaging discharge currents. Non-charge generating materials are designed to prevent the generation of static charge but are not adequate for shielding. Conductive and static dissipative materials are available that prevent the generation of charge and to be adequate static shields.

d. ESD Control Products. ESD Control products are required to implement the rules in paragraph (2). Precisely which and how may products are needed is determined during the work area ESD Control survey (see paragraph 7-7). The following paragraphs describe these products in terms of their applications and physical characteristics.

NOTE

Only products qualified through the Air Force ESD Control Technology Center and included in Table 7-3 may be used in Air Force facilities.

(1) Static Control Workstations. There are four types of static control workstations appropriate for various applications.

* Permanent Static Control Workstation
* Static Control Workstation (with cushioned work surface)
* Static Control Workstation (with rigid work surface)
* Portable Static Control Workstation

Each type of workstation has three principal components: (1) Static Dissipative Work Surface, (2) Personnel Wrist Strap, and (3) Common Point Ground System (CPGS). Continuous workstation monitors are currently optional depending on the requirements of the work area survey (see paragraph 7-7). A description of each workstation type is provided below.

(a) Permanent Static Control Workstation. This workstation is one in which the static dissipative work surface is built into the workbench itself (i.e. laminated, pressure formed, etc.). A personnel wrist strap (adjustable cuff and either 5 ft. or 10 ft. cord) shall be included at this station. The station shall also utilize a common point

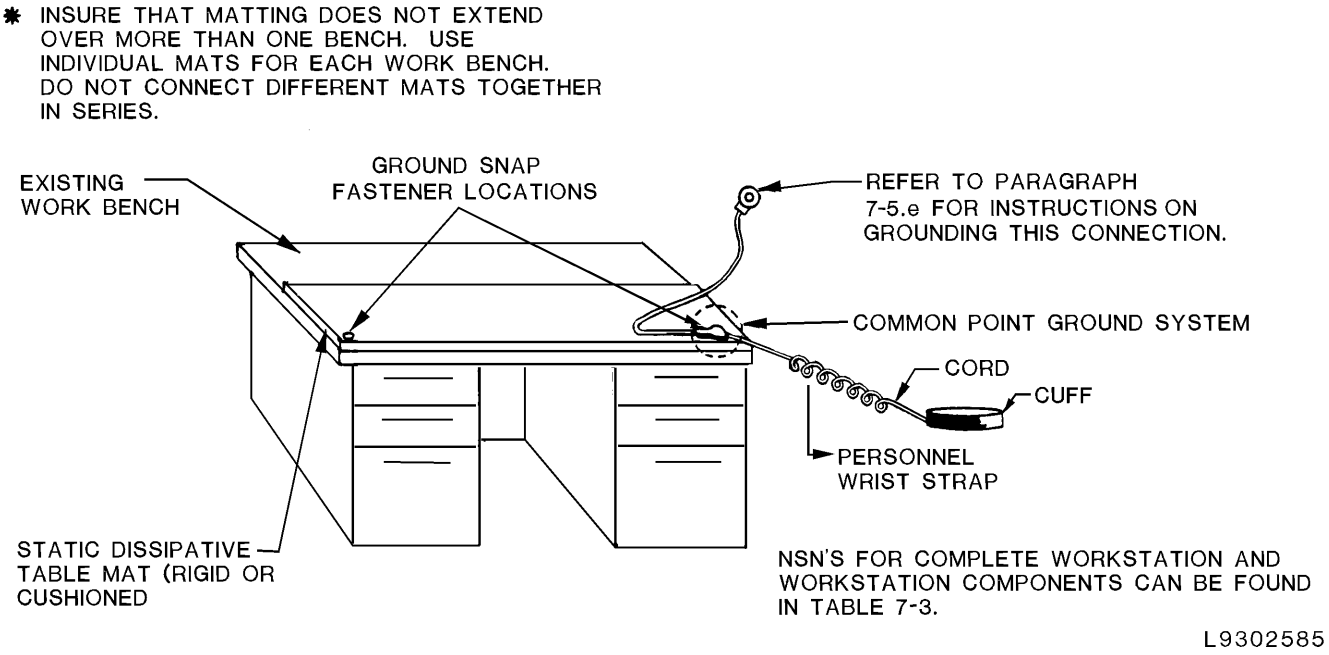


Figure 7-4. Static Control Workstation (work cushioned or rigid work surface on an existing work bench)

ground system for ensuring the wrist strap and work surface are tied to the same point electrically prior to grounding. Figure 7-3 shows a conventional permanent static control workstation without the continuous workstation monitor. The Continuous Workstation Monitor (if not previously installed) shall be installed per the manufacturers instructions provided.

Various features for permanent workstations including drawers, riser shelves and power outlets are available.

Continuous workstation monitors are included with each of the permanent workstations listed in Table 7-3. The monitor continuously checks the resistance of the workstation, operator, and connections to ensure that all are effectively grounded. The personnel wrist strap that must be used with this monitor is different from the standard wrist strap described earlier in this paragraph. It has a dual conductor cord so that a resistance measurement can be made from the monitor, through the cord to the cuff, through the wearer's wrist, into the cuff again and back to the monitor through the other conductor in the cord. The monitor is also equipped with a remote wrist strap jack. This would be used instead of the dual banana system shown in Figure 7-3 whenever a continuous workstation monitor is used. The continuous monitor does however have an additional grounded banana jack to accommodate standard, single conductor wrist straps. Note however that the banana jack is not monitored and any wrist strap connected there shall be tested in accordance with paragraph 7-8.

NOTE

The dual conductor wrist strap cord and cuff can only be used when workstation monitors are incorporated. They will not work with the conventional banana jack shown in figure 7-3.

Periodic testing of the worksurface and inner surfaces of cabinets and drawers within a permanent workstation is required in accordance with paragraph 7-6. Testing shall be conducted in accordance with paragraph 7-8. Paragraph 7-5.e. provides directions for grounding permanent workstations. Workstations that utilize a continuous monitor require an additional ground connection (for the monitor itself). It is the same electrically as the one outlined for the workstation in paragraph 7-5.e.

(b) Static Control Workstation (with cushioned work surface). This workstation consists of a cushioned, four-foot by two-foot static dissipative work surface, an adjustable wrist strap cuff and 5 foot cord and a common point ground system. It can be installed on any work bench or table and typically is used in applications where work surface cushioning is desired. Figure 7-4

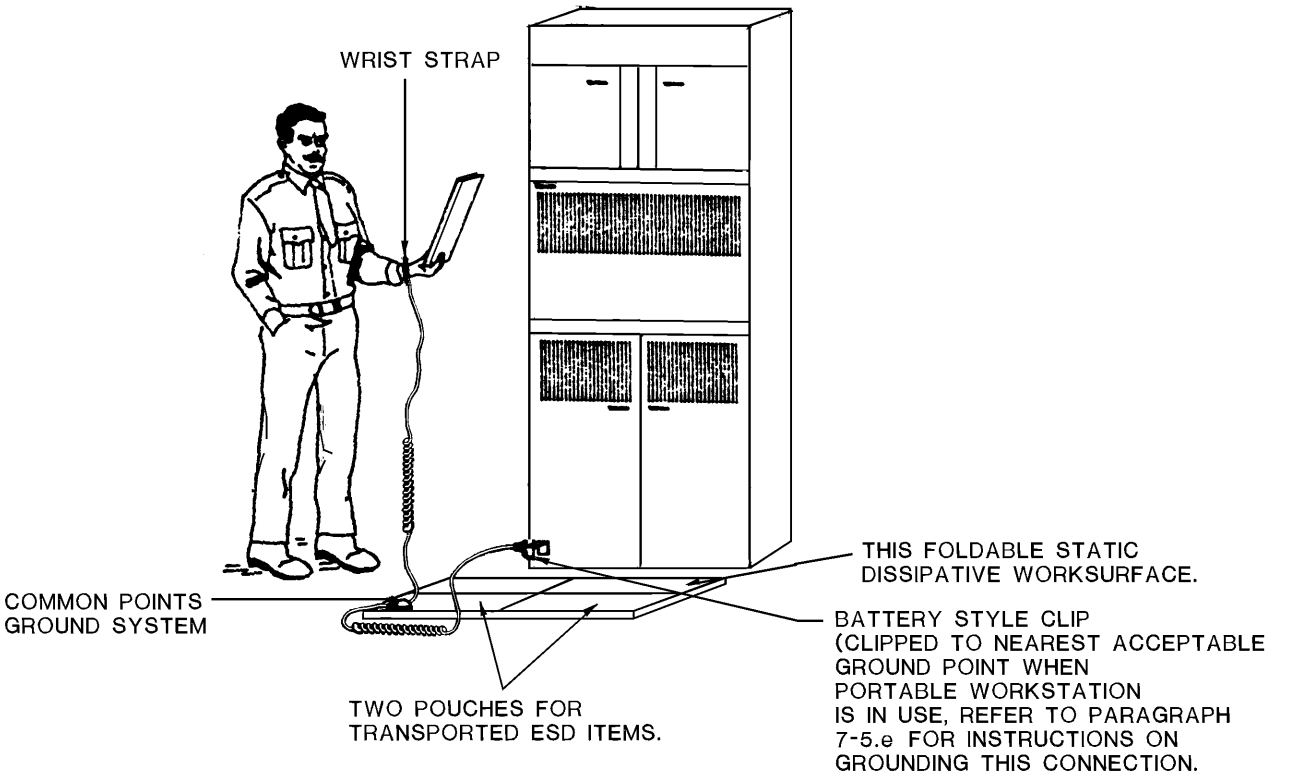


Figure 7-5. Portable Static Control Workstation

shows a typical workstation with the cushioned workstation on an existing work bench. A NSN has been established for a 40 ft. runner of the cushioned work surface material (see Table 7-3). The runner can be cut to fit uniquely shaped work bench surfaces. Note that if this is done, the common point ground system and wrist strap must still be attached to the cut work surface so that the proper workstation orientation is maintained. Grounding of the workstation shall be done in accordance with paragraph 7-5.e.

Periodic testing of the worksurface and the runner material is required in accordance with paragraph 7-6 to ensure they retain their ESD Control properties over time. Testing shall be conducted in accordance with paragraph 7-8.

Continuous workstation monitors can also be utilized at these workstations if required by the work area ESD Control survey (see paragraph 7-7). As mentioned earlier in this paragraph, a special dual conductor wrist strap cord and cuff must be used for the monitor to be effective. Installation instructions are provided with the monitor.

(c) Static Control Workstation (with rigid work surface). This workstation consists of a rigid, four-foot by two-foot static dissipative work surface, adjustable wrist strap cuff and 5 ft. cord, and a common point ground system. It can be installed on any existing work bench or table and can be used in clean room operations because of its resistance to abrasion. It can also be used in operations where large, heavy objects are handled which could damage the cushioned work surface. Moreover, the work surface can be physically modified to meet uniquely sized surfaces. Figure 7-4 shows a typical workstation with rigid worksurface on an existing work bench. Grounding of the workstation shall be done in accordance with paragraph 7-5.e.

Periodic testing of the worksurface is required in accordance with paragraph 7-6 to ensure it retains it's ESD Control properties over time. Testing shall be conducted in accordance with paragraph 7-8.

Continuous workstation monitors can also be utilized at these workstations if required by the work area ESD Control survey (see paragraph 7-7). As mentioned earlier in this paragraph, a special dual conductor wrist strap cord and cuff must be used for the monitor to be effective. Installation instructions are provided with the monitor.

(d) Portable Static Control Workstation: This workstation is a kit containing a thin, foldable, (approximately 22 inch by 24 inch) static dissipative work surface, an adjustable wrist strap cuff, a 10 ft. cord, and a common point ground system. It shall be used during remote maintenance or handling of ESDS items where the larger static control workstations mentioned in paragraphs 7-5.d.(1) (a), (b) and (c) cannot be installed or utilized. Grounding of the portable workstation shall be done in accordance with paragraph 7-5. e(6) . Figure 7-5 shows a typical portable workstation.

Periodic testing of the worksurface is required in accordance with paragraph 7-6 to ensure it retains it's ESD Control properties over time. Testing shall be conducted in accordance with paragraph 7-8.

(2) Personnel Wrist Strap. The personnel wrist strap is the single most important item for effective static control. It effectively drains static charge from the individual wearing it. Personnel handling ESDS items outside of their protective static shielding container or packaging shall wear a wrist strap. It consists of two components: (1) a woven or knitted elastic fabric cuff; and (2) a 5 or 10 ft. coiled, insulated and flexible cord. The cuff shall be worn snug to the wrist and shall be adjusted when necessary to ensure a snug fit.

WARNING

The personnel wrist strap shall not be worn when working on energized parts, assemblies and equipment.

Note that the wrist strap cuff and cord to be used with continuous workstation monitors described earlier vary from the standard NSN-listed wrist straps. As explained in paragraph 7-5.d.(1)(a), they have two wires in them and are only available in specific sizes; small, medium and large. They are not adjustable. They also have separate part numbers which are listed in Table 7-3.

One megohm resistors are built into the cords of both wrist strap style at the point where they attach to the wrist strap cuff. Periodic testing of the wrist strap is required per paragraph 7-6 and shall be tested in accordance with 7-8.

NOTE

The two wire wrist strap cord and cuff can only be used when continuous workstation monitors are used.

(3) Common Point Ground Systems (CPGS). A CPGS is required at any static control workstation that does not utilize a continuous workstation monitor. The CPGS ensures that the station's personnel wrist strap and the static dissipative work surface are connected physically and electrically at the same point.

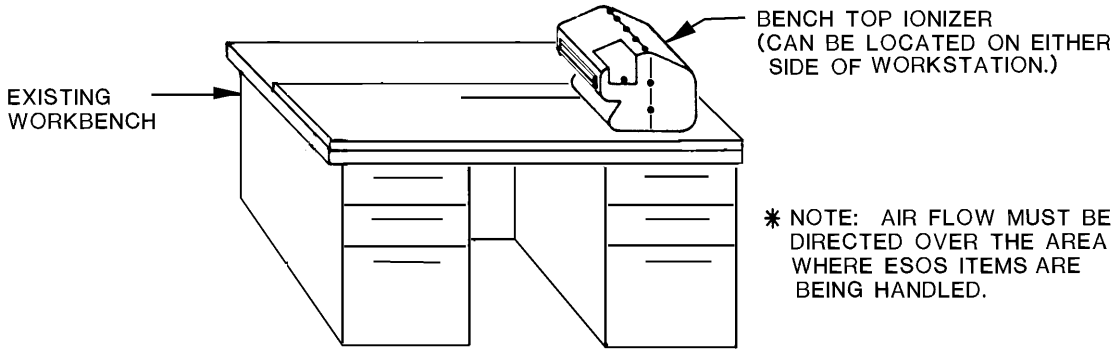


Figure 7-6. Bench Top Ionizer Positioning

The CPGS has a single ground line (15 ft.) that requires attachment to a verified ground termination point (ref paragraph 7-5.e. Figures 7-4 and 7-5 show the CPGS orientation as installed with the different workstations. There are two CPGS orientations also. One is used with the workstations outlined in paragraphs (b) and (c) and has a standard ring termination. The other is used with a portable workstation and has a clamp-type termination.

The common point ground concept varies slightly when continuous workstation monitors are used. The monitor continuously monitors the resistance of the worksurface ground path as well as the wrist strap cuff and cord and these functions require separate circuits. Because of this, the wrist strap and worksurface are not physically connected to a common point as is the case with workstations without the monitor.

(4) Bench Top Ionizers. Bench Top Ionizers are used to neutralize static charge on job essential, non-conductive or ungrounded-conductive items used at the ESD Control workstation. They are not required at every ESD control workstation. They are required at workstations handling the devices and doing the work specified in paragraph 7-7.d. (6) (b). Workstations utilizing bench top ionizers shall position them as shown in Figure 7-6.

There are two primary types of bench top ionizers. Those that generate ions through alpha emissions and those that generate ions electrically. Both types are considered satisfactory for use if required by the work area ESD Control survey. Both also require some degree of maintenance and/or accounting.

Ionizers that ionize through alpha emissions have two major assemblies. (1) A blower/housing for projecting the ions across the work surface and (2) an alpha emitting ionizing bar, for generating positive and negative ions. The blower is requisitioned through normal procedures, the model number can be found in Table 7-3. The ionizing bar is obtained through a lease contract and must be obtained locally. In addition, a USAF Radioactive Material Permit in accordance with AFR 161-16 and T.O. 00-110N-3 is required through the USAF Radioisotope Committee (HQ AFORMS/SGPR) at Brooks AFB, Texas. The permit must be acquired prior to receipt of the ionizing bars. Strict accountability and periodic swipe testing is required for the ionizing sources. The base/facility Radiation Safety Officer (RSO) can assist in the accounting, swipe testing and the permit/acquisition effort. Model numbers for the ionizing bars can be found in Table 7-3.

WARNING

Ionizers utilizing alpha emitting ionizing sources should be used with strict adherence to manufacturers safety guidelines and procedures. Use bench top ionizers only in situations outlined in paragraph 7-7.d.(5)(b).

Ionizers that generate ions electrically are also acceptable for use if required in the work area ESD Control survey. They vary from the alpha emitting ionizers in that they require periodic testing to verify their functionality. As a minimum, electrical ionizers shall be checked quarterly, by conducting discharge time and offset voltage tests. Periodic testing of ionizers is required in accordance with paragraph 7-6 and shall be tested in accordance with paragraph 7-8.

(5) Static Dissipative Garments. Static dissipative garments must perform two functions. First, they must be able to dissipate static charge from their surface to ground, and second, they must be resistant to triboelectric charge generation. Garments shall be worn in any clean room environment that already requires garments for particulate control and where ESDS items are handled. Information on qualified garment sources can be obtained from the Air Force ESD Control Technology Center, AGMC/MAE at DSN 346-7383.

(6) Static Dissipative Gloves and Finger Cots. Operations which involve the handling of ESDS items and require gloves or finger cots to control contamination from the hands shall utilize static dissipative gloves. The work area survey paragraph 7-7.d. (6) (f) will dictate whether gloves are necessary.

(7) Static Dissipative Flooring System. A static dissipative flooring system is a static control requirement when specified in the work area survey paragraph 7-7.d. (6) (e). A floor system includes static dissipative flooring, shoes and seating designed to remove static charge from personnel when handling ESDS items. Independently, each does not provide adequate ESD Control protection. They must be used simultaneously. Information regarding static dissipative flooring, shoes and seating are provided in the ensuing paragraphs.

(a) Static Dissipative Flooring. Static dissipative flooring is a static control requirement when specified in the work area survey. Qualified sources of flooring materials are not listed in this TO because styles and techniques will vary from

installation to installation. A periodic test method for installed flooring is provided in paragraph 7-8 and shall be used in accordance with paragraph 7-6. A specification for static dissipative flooring has been developed at the Air Forces ESD Technology Center and shall be used when qualifying a floor prior to installation. Grounding of static dissipative flooring shall be done at least one point per 10,000 sq. ft. of installed floor or part thereof with a minimum of 2 grounding points per floor.

No waxes or coatings shall be applied to the flooring at any time.

(b) Static Dissipative Shoes: Static dissipative shoes are a static control requirement when specified in the work area ESD Control survey. Periodic testing of shoes per paragraph 7-6 is required to ensure continued ESD Control performance. The test procedure is provided in paragraph 7-8.

(c) Static Dissipative Seating: Static dissipative seating is a static control requirement when specified in the work area ESD Control survey. Periodic testing of seating per paragraph 7-6 is required to ensure continued ESD Control performance. The test procedure is provided in paragraph 7-8.

(8) Grounded Electrical Tools and Equipment. Electrical equipment required to perform the work being done at the ESD Control workstation shall be properly grounded. Specifically, soldering irons, solder pots, or flow soldering and solder sucking equipment shall be hand grounded and the transformer isolated from the power line. The specific solder grounding techniques specified in Section III, paragraph 3-4b of this TO shall be utilized. Any other electrical tool or electrical equipment item that comes in contact with ESDS items shall also be grounded. This means that all exposed metallic surfaces of these equipment items shall be connected electrically via a grounded plug to the equipment items power system or other hard ground. This ensures that no potential difference (voltage) exists between ESDS items and equipment used at the workstation.

(9) Relative Humidity. Humid air helps to dissipate electrostatic charges by keeping surfaces moist. This increases surface conductivity and minimizes the chance for charge generation. In many cases though, the decreased static levels made possible by higher humidity are still large enough to destroy or degrade ESDS items. The requirement for the use of higher humidity levels for static control is governed by the work area static control survey and paragraph 7-7.d.(5)(c).

(10) Computer Keyboard Ground Strips: All personal computer, test equipment or other data processing keyboards used to repair, test, operate and maintain ESDS items shall be equipped with a conductive keyboard ground strip unless the following conditions exist. If the area is equipped with a static dissipative flooring system paragraph 7-5.d.(7) or if the computer is equipped with a personnel wrist strap, the keyboard ground strips are not required.

The strip easily attaches to the keyboard, is easily grounded and is used in lieu of a personnel wrist strap which is not feasible in computerized work areas. The requirement for use of these ground strips is defined by the work area ESD Control survey and paragraph 7-7.d. (6) (g). Figure 7-7 shows ground strip installation procedures.

CAUTION

Static fields associated with some computer CRT's are substantial and should be kept away from ESDS items.

(11) ESD Control Product and Ground Integrity Test Equipment. The specifications for the various ESD Control products referenced in this section were developed to ensure the military receives and continues to use quality and reliable ESD Control products. Verification of specification requirements is done with the following basic test equipment. However, some specifications require test equipment not available in many field or depot maintenance shops. The following equipment shall be obtained as required to verify that the electrical integrity of the ESD control products is maintained throughout their usable lives. Part numbers and NSNs for these equipment items can be found in Table 7-3. These test equipment items include:

(a) Electrostatic Field Meter. This device detects the presence of electrostatic fields emanating from a charged object. It is basically a tool for verifying whether or not electrostatic fields exist in the work place. It should not be used to make precise measurements. The ability of a material to generate charge can be roughly seen with the meter.

CAUTION

STATIC FIELDS ASSOCIATED WITH SOME COMPUTER CRT's ARE SUBSTANTIAL AND SHOULD BE KEPT AWAY FROM ESDS ITEMS.

COMPUTER KEYBOARD TOUCH STRIP INSTALLATION PROCEDURES

TOUCH STRIP GROUND CORD:

(1) TUCK GROUND CORD UNDER KEYBOARD AND COMPUTER.

(2) CONNECT GROUND CORD TO CHASSIS SCREW ON REAR OF COMPUTER.

(3) ELECTRICALLY CHECK TO ENSURE CHASSIS SCREW HAS ELECTRICAL CONTINUITY TO THE ROUND PIN (GROUNDING CONDUCTOR) OF THE COMPUTER'S POWER PLUG.

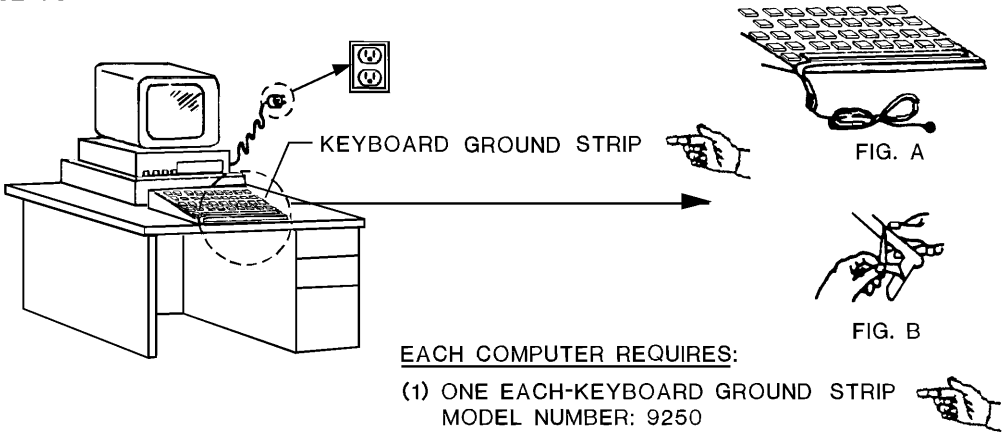
REFER TO PARAGRAPH 7-5.e FOR INSTRUCTIONS VERIFYING THE GROUND INTEGRITY OF THE ELECTRICAL OUTLET USE TO POWER THE COMPUTER.

TOUCH STRIP INSTALLATION INSTRUCTIONS:

(1) DETERMINE PROPER LOCATION ON KEYBOARD. OPERATOR'S HANDS WHEN AT REST SHOULD TOUCH THE STRIP NATURALLY. (SEE FIG. A)

(2) REMOVE LINER AND ADHERE STRIP TO KEYBOARD. (SEE FIG. B.)

(3) CONNECT GROUND CORD EYELET TO A CHASSIS SCREW ON THE BACK OF THE MAIN COMPUTER. ELECTRICALLY ENSURE THE CHASSIS SCREW HAS ELECTRICAL CONTINUITY TO THE ROUND PIN OF THE CONPUTER'S POWER PLUG.



EACH COMPUTER REQUIRES:

(1) ONE EACH-KEYBOARD GROUND STRIP MODEL NUMBER: 9250

Figure 7-7. First Touch Installation Procedures

(b) Wrist Strap Tester. This device will allow the operator to check the integrity of his/her wrist strap cuff and cord. The tester allows for electrical continuity and resistance checks of both the wrist strap cord alone and of the entire wrist strap system while the operator is wearing it. It ensures that the resistance for both situations is between 1 and 10 megohms.

(c) Variable Voltage Megohmmeter. This instrument will allow for measurement of static dissipative work surfaces, floors, shoes, single layer static dissipative garments and the resistance of any other static control material that requires resistances in the one megohm to 1000 megohm range. One hundred (100) volts is the standard test voltage for most ESD control materials that require periodic testing per paragraph 7-8.

(d) Resistance Test Electrodes. Two, 5 lb. (+/1 oz.), 2.5 inch (+/-0.062 in.) diameter flat surfaced electrodes are required to make the resistance measurements with the megohmmeter mentioned in paragraph 7-5.d.(11)(c). The electrodes are prepared by placing a piece of heavy tin foil on a flat, hard and smooth surface. On top of the foil place a 2.5 inch diameter disk of 0.25 inch thick rubber that has a hardness of 50+/-10 as measured on a Shore type A Durometer which is described in Test Method "D" 2240 (Test Method For Rubber Property-Durometer Hardness). Place the electrode on top of the rubber pad, draw the foil up around the rubber pad and electrode. Secure the foil with a hose clamp. Repeat procedures for the second electrode. Electrodes that have conductive rubber do not need the tin foil, but the rubber

pads need to be cleaned with 70% isopropyl alcohol. Conductive rubber electrode pads (2.50 inches diam. x 0.25 inch thick) can be used with the electrodes in lieu of the aluminum foil/ rubber combination specified for the construction of the electrodes.

(e) Megohmmeter Test Kit. The kit contains the variable voltage megohmmeter and the 5 lb. electrodes referenced above.

(f) Ohmmeter. The ohmmeter is used to check the integrity of grounding conductors and bonding devices for ESD control workstations, cabinets and floors as well as solder guns or iron tip continuity. (see paragraph 7-5.e. for details).

(g) Ground Impedance and Utility Wiring Verification Meter. This meter is required for measuring the wiring accuracy in electrical systems and assuring that ground conductors (third wire) in power systems are effective for static drainage and safe for personnel usage. The meter is capable of analyzing the hot, neutral and equipment ground conductors of an electrical system. It will measure the impedance between neutral and the equipment ground conductors to verify the integrity of the ground point used in grounding static control workstations, cabinets or floors. Paragraph 7-5.e. provides details on the use of this meter.

(h) Charged Plate Monitor. A charged plate monitor is used to verify the performance of bench top ionizers by measuring charge decay times and offset voltages. It shall have a 6 in. x 6 in. conductive plate (20 pf capacitance maximum) for a sensor. The monitor shall be capable of measuring decay times from initial plate voltages of +/- 1000 volts to +/-100 volts respectively.

(i) Air Velocity Meter. An air velocity flow meter is required to measure the speed of the air flowing from bench top ionizers when conducting periodic performance tests. The meter shall be capable of measuring velocities of at least 550 Ft/Min (FPM) at a distance of 6 inches from the ionizer (see paragraph 7-8. f.)

(j) Consolidated Test Kits. Consolidated Test Kits are available and include the following equipment:

(1) Kit A: Field meter, wrist strap tester, megohmmeter, 2 test electrodes, ground impedance verification meter, charge plate monitor and air velocity meter.

(2) Kit B: Field meter, wrist strap tester, megohmmeter, 2 test electrodes and ground impedance verification meter.

(a) Kit A is for areas where air ionizers must be used and tested. Kit B is available for areas without the requirement for air ionizers. These kits provide bases or organizations with multiple ESD controlled areas a means of sharing this specialized test equipment. The consolidated test kit is also a more cost efficient option for organizations required to initially purchase most or all of the prior mentioned test equipment.

(12) Packaging Materials - ESD protective packaging is required anytime an ESDS item is stored or transported. Static shielding and non-charge generating materials shall be used. This typically means using combinations of all 3 types of materials outlined in MIL-B-81705. Type I is shielding barrier material made to withstand many phenomenon outside of ESD. Type II is an "antistatic," non-charge generating material. Type III is a static shielding material. The packaging materials required and conditions for their use with ESDS items are described in the following paragraphs.

(a) Discrete ESDS Parts (see paragraph 7-4.a.(1) shall be received from the manufacturer packaged as follows:

1 The first wrap shall be antistatic material conforming to MIL-B-81705 Type II. Other material, such as PPP-C-1842, Type III, Style A or B, or PPP-C-795, Class 2, or PPP-C-1752, Type VII, Class 4, or PPP-C-1797, Type II, may be used with, or in lieu of, MIL-B-81705, Type II.

2 The wrapped/cushioned item shall then be placed in a heat sealed bag conforming to MIL-B-117, Type I, Class F, Style 1 (MIL-B-81705, Type I).

3 No plastic or insulative/non-conductive materials shall be used as the item wrap, nor shall they be used inside the MIL-B-117 (MIL-B-81705, Type I) bag. In addition, discrete part lead holders made of plastics or non-conductive materials shall not be used.

4 In cases where parts are being transported between supply/distribution and maintenance organizations, either MIL-B-81705, Type I or III pouches/bags shall be used. If Type I bags or pouches are used, the parts shall be initially wrapped in an antistatic material as indicated in paragraph 1. Again, no plastic or insulative/non-conductive materials shall be used on or around the parts. The pouches or bags shall be sealed prior to shipment to the next organization.

(b) Circuit Boards, wiring boards, modules (see paragraph (2)) shall be packaged in one of the following manners:

1 If the circuit boards are bare items and transported or stored locally (in-house), they shall be packaged by one of these methods:

a In a static shielding pouch/bag conforming to MIL-B-81705, Type III.

b Placed in a MIL-B-81705, Type II material (per PPP-C-1842) then placed in a MIL-B-81705, Type I pouch/bag.

c In a pouch/bag with verifiable MIL-B-81705, Type II inner properties (non-charge generating) and MIL-B-81705, Type I or III outer properties (static shielding). This bag is usually custom made.

NOTE

For all three options, the shielding pouch/bag shall be sealed or closed when an ESDS item is inside.

2 If the circuit boards or modules are bare items with paperwork that are to be transported or stored locally (in-house), they shall be packaged the same as bare items with these additional requirements:

a When using method a, an additional outer bag/pouch made of MIL-B-81705C, Type II or III material is required. Paperwork shall be placed between the two bags.

b When using method b, paperwork shall be placed in a non-charge generating pouch adhered to the outside of the Type I pouch/bag.

c When using method cnon-charge generating pocket is required on the outside of the pouch/bag to hold the paperwork.

NOTE

For all three options, the shielding pouch/bag shall be sealed or closed when an ESDS item is inside.

WARNING

Charge generating tapes (i.e. masking, scotch, duct, etc.) shall not be used to seal or mark the bags mentioned above. Charges generated may be substantial and damage ESDS items. Additionally, staples shall not be used to seal/close these bags.

3 Cushioning Option - Cushioning can be achieved by utilizing MIL-P-81997, Type I, or PPP-C-1842, Type III, Style A or B, or PPP-C-1797, Type II materials to prevent bag puncture and provide adequate protective cushioning for each circuit board or module being transported or stored. Note that these five cushioning alternatives are for MIL-B-81705, Type II materials only. Type III cushions are not typically available but when they are the cushioning requirements of PPP-C-1842, PPP-C-795, PPP-C-1752 and PPP-C-1797 must be met. The cushioning requirement is optional and is dependent on local policy and the fragility of the item(s). If cushioning is used, ensure that the packaging configurations specified in paragraph 7-5.d.(12)(b)1and 7-5.d.(12)(b)2 are maintained.

CAUTION

Some MIL-B-81705, Type II and Type III materials may introduce corrosive or solderability problems to solder coatings associated with circuit boards, wiring boards and modules.

4 All items, both reparable and serviceable, (i.e. circuit boards, wiring boards and modules) being transported from base to base, to/from a contractor's facility or cross country in any way shall be transported in the packaging options provided in paragraphs 7-5.d.(12)(b)1and 7-5.d.(12)(b)2 with an additional MIL-B-81705, Type I pouch or bag placed around the original packaging materials. The Type I material provides a barrier against many different destructive outside forces other than ESD that can be encountered during transit. If the Type I material already is the outermost package (as received from the repair/test facility), a second Type I outer pouch is not necessary. In most cases, the packaging developed by the prime ALC will require the packaged item to be placed in a Fast Pack container conforming to PPP-B-1672. When placed in the Fast Pack container, the item is afforded adequate physical shock protection for shipment.

(c) Uniquely Shaped or Fragile Assemblies With Exposed ESDS Parts. These kinds of items basically are any assembly other than circuit boards, wiring boards or modules that have exposed ESDS parts attached. The packaging options outlined in paragraph (b) for circuit boards, wiring boards or modules are acceptable for these items if they are rigid/stable enough to be transported or stored in pouch/bag materials without fear of damage to the item. If the item is too fragile for transport in bags or pouches, then lidded conductive tote boxes with non-corrosive

conductive foam interiors shall be used. The foam can be cut to conform to the shape of the item being transported. Ensure that when using cut, conductive foam, that it has been vacuumed and cleaned to remove all loose conductive particles generated by the cutting process. The conductive tote box shall have a conductive lid to ensure total static shielding capabilities. Tote boxes must conform to static shielding requirements similar to those required of static shielding bags/pouches. These techniques apply only to in-house transit (i.e. from repair bench to repair bench, repair to test, organization to organization) of these items. Distribution or packaging organizations receiving items from the repair/test facility for shipment off base, must remove the item from the tote box and package it per the required packaging data developed by the prime ALC (i.e. 0013). This must be done at an ESD Control workstation. The discarded conductive tote box and foam must be returned to the original user.

1 There will be instances when multiple ESDS items will need to be transported in a single tote box. The same tote boxes listed in Table 7-3 can be used for these circumstances. Again this method is acceptable only for in-house transit of ESDS items. Packaging or distribution organizations shall ship these items off base individually packaged per the required packaging data developed by the prime ALC (i.e. 0013).

2 There will be situations where these types of assemblies will require transport in and out of clean areas. Different containers are therefore necessary to minimize contamination effects. Part Numbers for static shielding containers that minimize contamination effects are also listed in Table 7-3. Lids are also required for these containers and are listed in Table 6-3. Part numbers for smaller, hinged containers made of the same material are listed in Table 7-3.

(d) Complete Systems, "Black Boxes", LRUs, SRUs, Test/Repair Equipment items or any end item (see paragraph 7-4.a.(3). The chassis or frame of these items, if made of a metal or conductive material, will act as a "Faraday Cage" or electrostatic shield against static fields or discharges to the item. The connectors or plugs on these items used to apply power or send information to/ from the inner circuitry represent a "hole" in the "Faraday Cage"and provides a path by which an ESD pulse can travel, and shall be covered with a conductive cap/plug to complete the faraday cage. Be aware that some test equipment items such as oscilloscope amplifiers or system testers have probe detector rings at the base of their BNC connectors. Conductive caps will short out the ring. Caps containing a shallower depth shall be used to prevent shorting. Screw-on metal caps are used to complete the "Faraday Cage"around the ESDS inner circuitry. Conductive caps or plugs shall be used when no screw-on metal caps exist to cover these connectors and complete the "Faraday Cage". Various sizes are listed in Table 7-3. In addition, a thermo formable sheet material made of conductive material is included in table 7-3 to make unique-sized caps that are not found in table 7-3.

(13) Marking. To ensure that personnel handling ESDS items are aware of the items' sensitivity to ESD, proper ESD marking procedures shall be implemented. ESD marking procedures shall be utilized on all ESDS items, procedural documentation, ESD packaging materials and on ESDS item storage cabinets and bins. Many of the specified labels do not have NSNs or part numbers although they are listed in Table 7-3. Organizations should contact the base Publications Distribution Office (PDO) or local businesses to have these labels made in the specified sizes. Color schemes for each label are black letters or symbols against a yellow background. NSNs or part numbers for each label shall be added to the table as they become available. Marking requirements are as follows:

(a) Marking of ESDS Items (Hardware). Marking of all items (actual hardware) listed in paragraphs 7-4.a.(1) and 7-4.a.(2) of this TO is dependent on the space available on the item itself and whether the environment of the ESD item such that marking materials are tolerable and do not hinder the operation of the item. When neither of the above conditions exist, the item shall be marked on an exterior surface with the MIL-STD-1285 sensitive device symbol shown in Figure 7-8. The symbol shall be placed on the ESDS item such that it is readily visible to personnel handling the item.

In addition, the following ESD caution statement (required in accordance with MIL-STD-1686) shall be placed on ESDS items adjacent to the MIL-STD-1285 symbol, if space permits:

"CAUTION CONTAINS PARTS AND ASSEMBLIES SUSCEPTIBLE TO DAMAGE BY ELECTROSTATIC DISCHARGE (ESD)"

A label combining both the MIL-STD-1285 symbol and the above caution statement can be used in lieu of obtaining both labels, if space permits. This label is shown in Figure 7-9.

Table 7-3. lists various sizes of the MIL-STD-1285 symbol, MIL-STD-1686 caution statement. If MIL-STD-1285 symbol, MIL-STD-1686 caution statement or combination label cannot be placed on the ESDS item, the packaging used for transport of

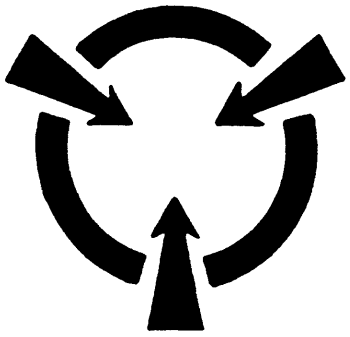


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Figure 7-8. MIL-STD-1285 Symbol

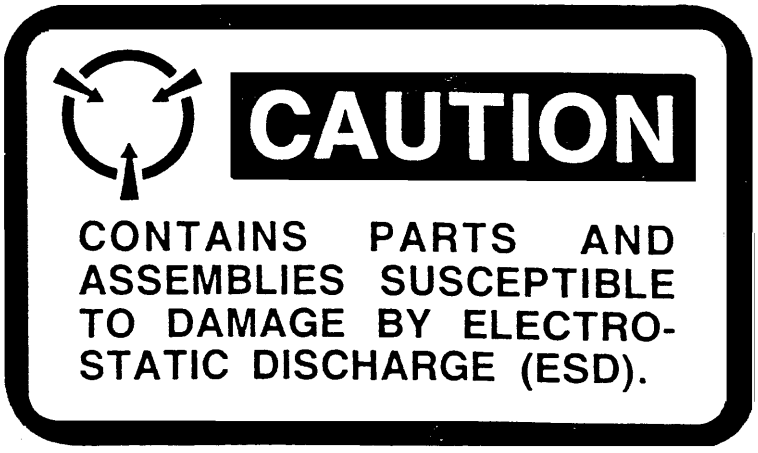

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Figure 7-9. MIL-STD-1285 Symbol/MIL-STD-1686 Caution Combined

the item must have the appropriate marking in accordance with paragraph 7-5.d.(13)(c).

(b) Marking ESDS Items That Require No Further Packaging. The items specified as ESDS in paragraph 7-4.a.(3) and packaged in accordance with paragraph 7-5.d.(12)(d) require no further packaging but often are put into or wrapped with additional static shielding or non-charge generating materials unnecessarily. Because of these discrepancies an ESD attention label is necessary on these items to restrict additional ESD protective packaging and to inform the handling individual that ESDS items are inside.

(c) Marking of Packaging Materials (Ref paragraphs 7-5.d.(12)(a),(b), and (c). When ESDS discrete parts, circuit boards, wiring boards, modules, and uniquely shaped items are packaged per paragraphs 7-5.d.(12)(a),(b), and (c), outermost bag will be marked on both sides with the label shown in Figure 7-11. When one or more of these items are packaged into another container for shipping purposes (i.e. Fast Pack, intermediate pack, exterior pack, shipping container) the ESD caution label shown in Figure 7-12 will be placed on the Fast Pack, intermediate pack, exterior pack or shipping container. See MIL-STD-129 for proper placement and correct size label to be used. See Table 7-3 for NSN and size of label.

(d) Marking Of Cabinets And Bins Containing ESDS Items. All storage cabinets or parts bins containing ESDS items outlined in paragraph

7-4.a. shall be marked on an outside surface clearly visible to personnel approaching the cabinet/bin alerting them that ESDS items are inside. The label displayed in figure 7-11 shall be used for this function. Note that items enclosed in a complete Faraday Cage are no longer consider ESDS; therefore, cabinets containing these items do not require special marking.

(e) Due to recent changes to the ESDS symbol outlined in MIL-STD-129, the use of the "three arrows in a circle" will be discounted and replaced with the "triangle and reaching hand" symbol shown in figures 7-11 and 7-12. Current supplies of labels using the "Three arrows in a circle" symbol may be exhausted before proceeding with the new MIL-STD-129 symbol.

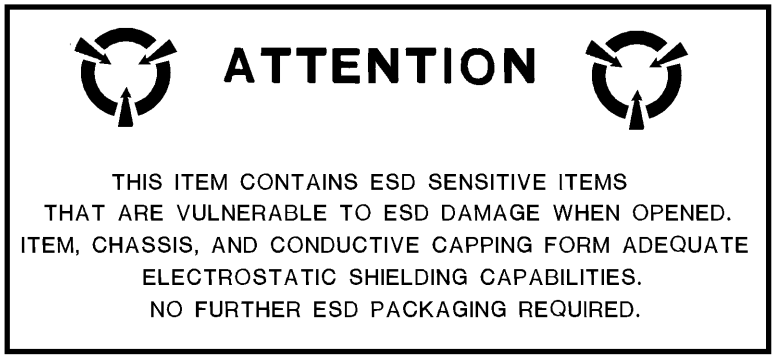

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Figure 7-10. ESD Attention Label/No Further Packaging Required

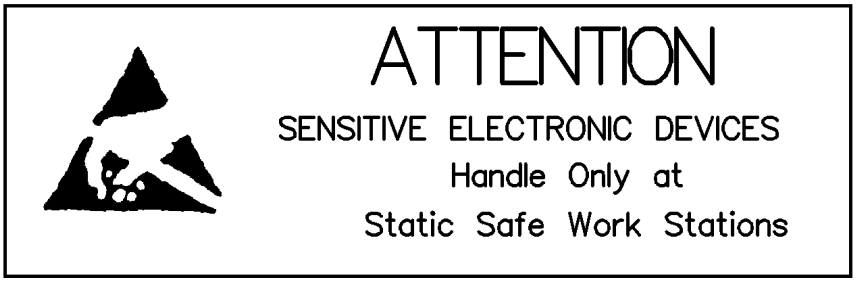

Figure 7-11. ESD Control Label/ESDS Item Packages

Figure 7-12. ESD Caution Label/Off Base Transport of ESDS Items

Table 7-3. ESD Protective Equipment

Item No.	Item/Nomenclature	NSN	Part Number
1	Permanent Workstation Size: 72 x 36 (4 drawer storage cabinets, continous workstation monitor, and dual conductor wrist strap) [ref paragraph 7-5.d.(1)(b)]	7110-01-377-8160	WEA01N5211VAA or WEA01N5194VAB (w/casters)
2	Permanent Workstation Size: 72 x 36 (5 drawer storage cabinets, adjustable shelf, continuous workstation monitors and dual wrist strap)	7110-01-377-7957	WEA03N5213VAA or WEA03N5195VAB (w/casters)
3	Permanent Workstation Size: 72 x 36 (5 drawer storage cabinets, shelf, continuous workstation wrist strap)	7110-01-377-8155	WEA04N5218VAA or WEA04N5219VAB (w/casters)
4	Permanent Workstation Size: 72 X 36 (5 drawer storage cabinets, adjustable powered shelf, continous workstation monitor, dual conductor wrist strap)	7110-01-377-5403	WEA04N5209VAA or WEA04N5192VAB (w/casters)
5	Permanent Workstation Size: 72 x 36 (5 drawer storage cabinet, powered shelf, continuous workstation monitor, and dual conductor wrist strap, additional 9 drawer storage cabinet) [ref paragraph 7-5.d.(1)(b)]	7110-01-377-8152	WEC04N5214VAA or WEC04N5193VAB (w/casters)

Table 7-3. ESD Protective Equipment - Continued

Item No.	Item/Nomenclature	NSN	Part Number
6	Permanent Workstation Size: 96 x 36 (2 and 4 drawer storage cabinets, shelf, 2 overhead storage bins, 2 high intensity lights, continuous workstation monitor, and dual conductor wrist strap)	7110-01-378-6454	809636-BESD
7	Permanent Workstation Size: 72 x 30 (2 and 3 drawer storage cabinets, power strip, continuous workstation monitor and dual conductor wrist strap)	7110-01-383-0171	537230-2ESD
8	Permanent Workstation Size: 72 x 36 (2 and 3 drawer storage cabinet, shelf, power strip, continuous workstation monitor and dual conductor wrist strap)	7110-01-377-8897	537236-4ESD
9	Permanent Workstation Size: 72 x 36 (2 and 3 drawer storage cabinet, power strip, continuous workstation monitor and dual conductor wrist strap)	7110-01-377-8896	537236-5ESD
10	Permanent Workstation Size: 80 x 30 (4 and 5 drawer storage cabinets, shelf, power strip, continuous workstation monitor and dual conductor wrist strap)		807230-3ESD
11	Permanent Workstation Size: 72 x 36 (3 and 4 drawer storage cabinets, shelf, power strip, continuous conductor wrist strap)	7110-01-383-0178	807236-AESD
12	Permanent Workstation Size: 72 x 36 (1 and 2 drawer storage cabinets, shelf, power strip, 2 overhead storage bins, high intensity lighting, continuous workstation monitor and dual conductor wrist strap)	7110-01-382-8050	807236-6ESD
13	Workstation, Static Control (Cushioned Worksurface 2x4 ft.) [ref paragraph 7-5.d.(1)(b)]	4940-01-250-4236	
14	Workstation, Static Control (Rigid Worksurface 2x4 ft.) [ref paragraph 7-5.d.(1)(c)]	4940-01-250-4235	
15	Workstation, Static Control Portable [ref paragraph 7-5.d.(1)(d)]	4940-01-250-4237	
16	Cushioned Static Control Worksurface Only (For workstation specified as item no. 13) [ref paragraph 7-5.d.(1)(b)]	4940-01-269-0444	
17	Rigid Static Control Worksurface Only (For workstation specified as item no. 15) [ref paragraph 7-5.d.(1)(c)]	4940-01-269-0443	
18	Portable Static Control Work Surface Only (For workstation specified as item no. 15) [ref paragraph 7-5.d.(1)(d)]	4940-01-269-0445	

Table 7-3. ESD Protective Equipment - Continued

Item No.	Item/Nomenclature	NSN	Part Number
19	40 ft. Work Surface Runner (4 ft. wide) (Made out of work surface material specified as item no. 16) [ref paragraph 7-5.d.(1)(b)]	4940-01-279-4608	
20	Personnel Wrist Strap (Adjustable Cuff and 5 ft. coiled cord) [ref paragraph 7-5.d.(2)]	4940-01-270-0442	
21	Personnel Wrist Strap (Adjustable Cuff and 10 ft. coiled cord)	4940-01-187-2267	
22	Wrist Strap adjustable Cuff Only	4940-01-274-0485	
23	Wrist Strap Cord (10 ft.)	4940-01-274-0487	
24	Wrist Strap Cord (5 ft.)	4940-01-274-0486	
25	Continuous Workstation Monitors [ref paragraph 7-5.d.(1)(a)]		Model 720
	Note: Dual Conductor Wrist Straps must be used with Continuous Workstation Monitors		
26	Dual Conductor Fabric Wrist Strap (band and 5 ft. cord) Size: Small [ref paragraph 7-5.d.(2)]		2361
27	Dual Conductor Fabric Wrist Strap (band and 5 ft cord) Size: Medium		2362
28	Dual Conductor Fabric Wrist Strap (band and 5 ft. cord) Size: Large		2363
29	Dual Conductor Fabric Wrist Strap (band only) Size: Small		2364
30	Dual Conductor Fabric Wrist Strap (band only) Size: Medium		2365
31	Dual Conductor Fabric Wrist Strap (band only) Size: Large		2366
	Note: The following two common point ground components are required for grounding permanent static control workstations without continuous workstation monitors.		
32	Common Point Ground Component (wrist strap portion) for Permanent Static Control Workstations [ref paragraph 7-5.d.(1)(a)]		3042
33	Common Point Ground Component (worksurface portion) for Permanent Static Control Workstations [ref paragraph 7-5.d.(1)(a)]		3041

Table 7-3. ESD Protective Equipment - Continued

Item No.	Item/Nomenclature	NSN	Part Number
34	Common Point Ground System (for static control workstations containing rigid and cushioned worksurfaces), ring terminal terminus [ref paragraph 7-5.d.(3)]	4940-01-270-5875	
35	Common Point Ground System (for portable static control workstations), clamp terminus [ref paragraph 7-5.d.(3)]	4940-01-248-9306	
36	Bench Top Ionizing Blower (for use with alpha emitting ionizing source) [ref paragraph 7-5.d.(4)]		Model 4062
37	Bench Top Alpha Emitting Ion Bar [Method of Acquisition specified in paragraph 7-5.d.(4)]		Model P-2001B
	Note: Model 4062 ionizing blower must be used with Model P-2001B ionizing source.		
38	Bench Top Electrical Ionizing Blower [ref paragraph 7-5.d.(4)]		Model 961
39	Static dissipative Gloves pair [ref paragraph 7-5.d.(6)] Size: small		G7238-1096-133
	Note: These gloves are not for use with solvents		
40	Static Dissipative Gloves, pair Size: Medium		G7238-1196-233
	Note: These gloves are not for use with solvents		
41	Static Dissipative Gloves, pair Size: large		G7238-1296-333
	Note: These gloves are not for use with solvents		
42	Static Dissipative Gloves, pair Size: x-large		G7238-13
	Note: These gloves are not for use with solvents		
43	Static dissipative Gloves, pair Size: S=small; M=medium L=large [ref paragraph 7-5.d.(6)]		27G-2700S; M;L 25G-2500S; M;L
44	Static Dissipative Finger Cots Sizes: Small, Medium, Medium/Large, Large/X-Large (must specify size on requisition documents) [ref paragraph 7-5.d.(6)]		8C-800
45	Static Dissipative Shoes, pair, steel toe Sizes: M5-9 10 (M-men) W5-9, 10 (W-women) (must specify size on requisition documents; Soft Brown Camp Moc Leather) [ref paragraph 7-5.d.(7)(b)]		Style 423

Table 7-3. ESD Protective Equipment - Continued

Item No.	Item/Nomenclature	NSN	Part Number
46	Static Dissipative Shoes, pair, steel toe Sizes: M5-10, 11 W-10, 11 (must specify size on requisition documents; Black Glove Leather)		Style 426
47	Static Dissipative shoes, pair, steel toes Sizes M7-11 12, 13 W7-11, 12, 13 (must specify size on requisition documents; Grey Soft Full Grain Leather)		Style 1611
48	Static Dissipative Shoes, pair, steel toe Sizes M7-11 12,13, W7-11 must specify size on requisition documents; Soft Black Full Grain Leather)		Style 1636
49	Static Dissipative Shoes, pair, steel toe, high-top leather Sizes C8-12, 13 D, E 6-12, 13 EEE7-12, 13 (Leather upper 6″ height Tan)		Style 961
50	Static Dissipative Shoes, pair, steel toe Sizes D7-11, EE7-11, 12, 13 (Black Smooth Leather)		Style 1764
51	Static Dissipative Shoes, pair, steel toe Sizes D8-11, 12, 13, EE8-11, 12, 13 (Cordo Smooth Leather)		Style 1765
52	Static Dissipative Shoes, pair Sizes B5-11, C4-11, D5-11 (White Tennis Shoe; Womans)		Style E315
53	Static Dissipative Shoes, pair Sizes D6-12, 13, E6-12, 13 (White Tennis Shoe; Mens)		Style E462
54	Chair, Static Dissipative Upholstered arms, Foot Ring, Contoured Seat, Adjustable Seat Height 22 in. - 27.5 in. [ref paragraph 7-5.d.(7)(c)]		J757ESDHF
55	Chair, Static Dissipative Foot ring, Contoured Seat, Adjustable Seat Height 22 in. - 27.5 in.		J757ESDBF
56	Chair, Static Dissipative Upholstered arms, Seat Height 22 in. - 27.5 in.		J702ESDH
57	Chair, Static Dissipative Foot ring, Contoured Seat, Adjustable Seat Height 22 in. - 29 in.		E3300ETF124-H-06B
58	Chair, Static Dissipative Upholstered arms, Foot ring, Contoured Seat, Adjustable Seat Height 21 in. - 29 in.		E3300ETF124-HG-06B
59	Computer Keyboard Ground Strip [ref paragraph 7-5.d.(10)]		9250
60	Electrostatic Field Meter [ref paragraph 7-5.d.(11)(a)]	6625-01-254-3059	Model 512

Table 7-3. ESD Protective Equipment - Continued

Item No.	Item/Nomenclature	NSN	Part Number
61	Wrist Strap Tester [ref paragraph 7-5.d.(11)(b)]		Model 746 (A/C Powered) Model 745 (Battery Powered) PFM-711AC
62	Variable Voltage Megohmeter [ref paragraph 7-5.d.(11)(c)]	6625-01-048-9678	Model L-10A PRS-800-M
63	Resistance Test Electrodes, pair (2.500 in. diam., 5 lbs.) [ref paragraph 7-5.d.(11)(d)]	5977-01-305-9120	260565 PRS-800-W
64	Conductive Rubber Electrode Pads, 2 each (2.500 in. dia., x .250 in. thick) [ref paragraph 7-5.d.(11)(d)]		CP 940A
65	Ohmmeter/Multimeter [ref paragraph 7-5.d.(11)(f)]	6625-01-213-9354	Model 77 PMM-810
66	Ground Impedance and Utility Wiring Verification Meter [ref paragraph 7-5.d.(11)(g)]	6625-01-124-5002 6625-01-192-1969	PAK-1A 7106 PST-601
67	Charged Plate Monitor (0 to 5000 volts range) [ref paragraph 7-5.d.(11)(h)]	6625-01-337-5308	Model 210
68	Charged Plate Monitor (0 to 5000 volts range)		Model TI 7000
69	Megohmmeter Test Kit [ref paragraph 7-5.d.(11)(e)]	6625-01-035-5602	Model 701 Model 260560 PRS-800
70	Consolidated Test Kit (w/change plate monitor and air velocity meter) [ref paragraph 7-5.d.(11)(j)]		AF/PAK-201A
71	Consolidated Test Kit [ref paragraph 7-5.d.(11)(j)]		AF/PAK-202B
72	Air Velocity Meter		Pan-750
73	Static Shielding Bags MIL-B-81705C, Type III [ref paragraph 7-5.d.(12)] Sizes: (all dimensions in inches) 3x5, 4x4, 4x6, 4x30, 6x8, 6x10, 8x8, 8x10, 8x12, 10x12, 10x14, 10x24, 10x30, 11x15, 12x18, and 18x18 Note: Requisition Documents must include part no. (any of those listed), size, zip lock seal requirement, and statement that the requirements of MIL-B-81705C must be met.	8105-01-361-1677 8105-01-363-7101	2100E 2110E 8300Z
74	PPP-C-1842, Type III cushion wrap material Size: .250 in. x 24 in. x 375 in. (bundle) [ref paragraph 7-5.d.(12)(b)3]	8135-01-087-3602	
75	PPP-C-1842, Type III cushion wrap material Size: .250 in x 12 in. x 375 in.	8135-01-087-3603	

Table 7-3. ESD Protective Equipment - Continued

Item No.	Item/Nomenclature	NSN	Part Number
76	PPP-C-1842, Type III cushion wrap material Size: .250 in. x 48 in. x 375 in.	8135-01-088-3850	
77	PPP-C-1842, Type III cushion wrap material Size: .250 in. x 6 in. x 375 in.	8135-01-088-3851	
78	MIL-P-81997, Type II pouches, cushioned [ref paragraph 7-5.d.(12)(b)] Size: 8 in. x 8 in.	8105-01-215-4752	
79	MIL-P-81997, Type I pouches, cushioned Size: 8 in. x 12 in.	8105-01-205-0207	
80	MIL-P-81997, Type I pouches, cushioned Size: 10 in. x 10 in.	8105-01-0497-2966	
81	MIL-P-81997, Type I pouches, cushioned Size: 10 in. x 12 in.	8105-01-197-7846	
82	MIL-P-81997, Type I pouches, cushioned Size: 12 in. x 12 in.	8105-01-197-2965	
83	MIL-P-81997, Type I pouches, cushioned Size: 11 in. x 15 in.	8105-01-215-4752	
84	MIL-B-81705, Type I material (heat sealable) [ref paragraph 7-5.d.(12)] Size: 3 ft. x 600 ft. (roll)	8135-00-092-3220	
	Note: This material can be cut and heat sealed to form the bags mentioned in paragraphs 7-5.d.(12)(a)4. Bags made from this material will be constructed by folding one piece of material and heat sealing on three sides in accordance with MIL-B-117. Do not make the bags from two separate pieces of material.		
85	MIL-B-81705, Type I bag, heat sealable [ref paragraph 7-5.d.(12)(a) and (b)] Size: 4 in. x 6 in.	8105-01-236-5944	
86	MIL-B-81705, Type I bag, heat sealable Size: 6 in. x 8 in.	8135-01-235-5473	
87	MIL-B-81705, Type I bag, heat sealable Size: 8 in. x 6 in.	8135-01-235-5474	
88	MIL-B-81705, Type I bag, heat sealable Size: 8 in. x 12 in.	8105-01-236-0149	
89	MIL-B-81705, Type I bag, heat sealable Size: 12 in. x 10 in.	8105-01-235-2688	
90	MIL-B-81705, Type I bag, heat sealable Size: 12 in. x 18 in.	8105-01-235-2689	
91	MIL-B-81705, Type I bag, heat sealable Size: 13 in. x 15 in.	8135-01-235-5476	

Table 7-3. ESD Protective Equipment - Continued

Item No.	Item/Nomenclature	NSN	Part Number
92	MIL-B-81705, Type I bag, heat sealable Size: 14 in. x 10 in.	8105-01-236-0150	
93	MIL-B-81705, Type I bag, heat sealable Size: 14 in. x 20 in.	8105-01-243-6628	
94	MIL-B-81705, Type I bag, heat sealable Size: 15 in. x 25 in.	8105-01-243-6629	
95	MIL-B-81705, Type I bag, heat sealable Size: 16 in. x 14 in.	8135-01-235-5477	
96	MIL-B-81705, Type I bag, heat sealable Size: 18 in. x 22 in.	8105-01-235-9829	
97	MIL-B-81705, Type II bag, uncushioned [ref paragraph 7-5.d.(12)(a) and (b)]		
	Size: 3 in. x 5 in.	8105-01-120-3382	
	4 in. x 4 in.	8105-01-120-3381	
	4 in, x 6 in.	8105-01-120-3380	
	4 in. x 24 in.	8105-01-119-8111	
	5 in. x 8 in.	8105-01-096-9527	
	5 in. x 10 in.	8105-01-120-3379	
	6 in. x 8 in.	8105-01-235-8223	
	6 in. x 10 in.	8105-01-120-3378	
	8 in. x 8 in.	8105-01-120-3377	
	8 in. x 10 in.	8105-01-120-3376	
	8 in. x 12 in.	8105-01-097-4507	
	9 in x 15 in.	8105-04-236-3974	
	10 in x 12 in.	8105-01-120-3375	
	10 in.x 14 in.	8105-01-120-3374	
	10 in. x 24 in.	8105-01-119-8110	
	11 in. x 15 in.	8105-01-120-3373	
	12 in. x 10 in.	8105-01-235-2670	
	12 in. x 16 in.	8105-01-120-3372	
	12 in. x 18 in.	8105-01-096-9528	
	14 in. x 10 in.	8105-01-235-2671	
	14 in. x 18 in.	8105-01-120-3371	
	14 in. x 20 in.	8105-01-235-2672	
	15 in. x 18 in.	8105-01-120-3370	
	15 in. x 25 in.	8105-01-235-5790	
	16 in. x 14 in.	8105-01-235-5791	
	18 in. x 18 in.	8105-01-119-8109	
	18 in. x 22 in.	8105-01-235-2673	
	30 in. x 24 in.	8105-01-235-9141	
98	PPP-C-795, Class 2, cushioning material, flexible, cellular plastic film for packaging applications [ref paragraph 7-5.d.(12)(b)3]		
99	PPP-C-1752, Type VII, Class 1, Grade B, cushioning material, packaging, unicellular polyethylene foam, flexible, antistatic sheet [ref paragraph 7-5.d.(12)(b)3]		

Table 7-3. ESD Protective Equipment - Continued

Item No.	Item/Nomenclature	NSN	Part Number
100	PPP-C-1797, Type II, cushioning material, resilient, low density unicellular, polyethylene foam .125 in. to .25 in. thick [ref paragraph 7-5.d.(12)(b)3]		
101	Tote Box, Static Shielding [ref paragraph 7-5.d.(12)(c)1] Size: 9 in. x 6.500 in. x 6 in. deep		4415A
102	Tote Box, Static Shielding Size: 14 in. x 9 in. x 3.500 in. deep		4423A
103	Tote Box, Static Shielding Size: 14.750 in. x 9 in. x 6 in. deep	3390-01-371-9180	4425A
104	Tote Box, Static Shielding Size: 14.750 in. x 9 in. x 8 in. deep	3990-01-060-4089	4425A
105	Tote Box, Static Shielding Size: 20 in. x 15 in. x 12 in. deep		4432A
106	Tote Box, Static Shielding Size: 20.750 in. x 15.750 in. x 5 in. deep	3990-01-290-5158	4435A
107	Tote Box, Static Shielding Size: 20.750 in. x 15.750 in. x 8 in. deep		4438A
108	Tote Box Cover, Snap-On (fits item no. 100) [ref paragraph 7-5.d.(12)(c)1]		4252A
109	Tote Box Cover, Snap-On (fits items 101, 102, 103)	3990-01-371-9272	4253A
110	Tote Box Cover, Snap-On (fits items 104, 105, 106)		4254A
111	Container, Static Shielding (for clean applications) [ref paragraph 7-5.d.(12(c)2] Size: 9.12 in. x 6.50 in. x 2.38 in. deep		DC1025CES
112	Container, Static Shielding (for clean applications) Size: 9.18 in. x 6.44 in. x 3.38 in. deep		DC1035CES
113	Container, Static Shielding (for clean applications) Size: 9.12 in x 6.44 in. x 4.88 in. deep		DC1050CES
114	Container, Static Shielding (for clean applications) Size: 14.69 in. x 9.12 x 2.38 in. deep		DC2025CES
115	Container, Static Shielding (for clean applications) Size: 14.75 in. x 9.18 in. x 3.38 in. deep		DC2035CES
116	Container, Static Shielding (for clean applications) Size: 14.81 in. x 9.25 in. x 4.88 in. deep		DC2050CES

Table 7-3. ESD Protective Equipment - Continued

Item No.	Item/Nomenclature	NSN	Part Number
117	Container, Static Shielding (for clean applications) Size: 14.88 in. x 9.31 in. x 5.88 in. deep		DC2060CES
118	Container, Static Shielding (for clean applications) Size: 14.81 in. x 9.25 in. x 6.88 in. deep		DC2070CES
119	Container, Static Shielding (for clean applications) Size: 14.75 x 9.18 in. x 7.88 in. deep		DC2080CES
120	Container, Static Shielding (for clean applications) Size: 20.12 in. x 15.12 in. x 4.88 in. deep		DC3050CES
121	Container, Static Shielding (for clean applications) Size: 20.12 x 15.12 in. x 5.88 in. deep		DC3060CES
122	Container, Static Shielding (for clean applications) Size: 20.12 in. x 15.12 in. x 7.88 in. deep		DC3070CES
123	Container, Static Shielding (for clean applications) Size: 20.12 in. x 15.12 in. x 11.88 in. deep		DC3120CES
124	Container Cover, Static Shielding (for use with items 110, 111 and 112) [ref paragraph 7-5.d.(12)(c)2]		CDC1040CES
125	Container Cover, Static Shielding (for use with items 113, 114, 115, 116, 117 and 118)		CDC2040CES
126	Container Cover, Static Shielding (for use with items 119, 120, 121, 122)		CDC3040CES
127	Container. Static Shielding with hinged lid (for clean applications) [ref paragraph 7-5.d.(12)(c)2] Size: 2.875 in. x 1.1875 in. x .500 in. deep		
128	Container, Static Shielding with hinged lid (for clean applications) Size: 3.875 in. x 1.937 in. x .500 in. deep		4022
129	Container, Static Shielding with hinged lid (for clean applications) Size: 2.500 in. x 3.500 in. x 1.750 in. deep		4023
130	Container, Static Shielding with hinged lid (for clean applications) Size: 7 in. x 3.500 in. x 1 in. deep		4024
131	Container, Static Shielding with hinged lid (for clean applications) Size: 7 in. x 5 in. x .500 in. deep		4025

Table 7-3. ESD Protective Equipment - Continued

Item No.	Item/Nomenclature	NSN	Part Number
132	Conductive, Non-corrosive Foam, Low Density for use in tote boxes and containers in items thru 122) ref paragraph 7-5.d.(12)(c) Size: 1.250 in. thick x 56 in. wide x 3 ft. length		CEC125X1
133	Conductive, Non-corrosive Foam, Low Density Size: 1.250 in. thick x 56 in. wide x 6 ft. length		CEC125X2
134	Conductive, Non-corrosive Foam, Low Density Size: 1.250 in. thick x 56 in. wide x 12 ft. length		CEC125X4
135	Conductive, Non-corrosive Foam, Low Density Size: 1.250 in. thick x 56 in. wide x 16 ft. length		CEC125X16
136	Conductive, Non-corrosive Foam, Low Density Size: 1.250 in. thick x 56 in. wide x 32 yds. length		CEC125X32
137	Conductive, Non-corrosive Foam, Low Density Size: .500 in. thick x 56 in. wide x 3 ft. length		CEC500X1
138	Conductive, Non-corrosive Foam, Low Density Size: .500 in. thick x 56 in. wide x 6 ft. length		CEC500X2
139	Conductive, Non-corrosive Foam, Low Density Size: .500 in. thick x 56 in. wide x 12 ft. length		CEC500X4
140	Conductive, Non-corrosive Foam, Low Density Size: .500 in. thick x 56 in. wide x 16 yards length		CEC500X16
141	Conductive, Non-corrosive Foam, Low Density Size: .500 in. thick x 56 in. wide x 32 yards length		CEC500X32
142	Conductive, Non-corrosive Foam, Low Density Sizes: .125 in. thick x 39 in. wide x 39 in. length .250 in. thick x 39 in. wide x 39 in. length .375 in. thick x 39 in. wide x 39 in. length .500 in. thick x 39 in. wide x 39 in. length Note: Requisition Documents must include part no. (any of those listed), and size. The shipping unit is a box of 10 sheets of foam.		2802
143	Conductive Connector Cap, Circular [ref paragraph 7-5.d.(12)(d)] Size: .250 in. dia., .500 in. depth		4270-4R
144	Conductive Connector Cap, Circular Size: .313 in dia., .500 in. depth		4279-5R

Table 7-3. ESD Protective Equipment - Continued

Item No.	Item/Nomenclature	NSN	Part Number
145	Conductive Connector Cap, Circular Size: .375 in. dia., .500 in. depth		4270-6R
146	Conductive Connector Cap, Circular Size: .413 in. dia., .625 in. depth		4270-8Y
147	Conductive Connector Cap, Circular Size: ,480 in. dia., .500 in. depth		4270-8R
148	Conductive Connector Cap, Circular Size: .500 in. dia., .500 in. depth		4270-9R
149	Conductive Connector Cap, Circular Size: .530 in. dia., .625 in. depth		4270-10Y
150	Conductive Connector Cap, Circular Size: .605 in. dia., .500 in. depth		4270-10R
151	Conductive Connector Cap, Circular Size: .655 in. dia., .625 in. depth		4270-12Y
152	Conductive Connector Cap, Circular Size: .720 in. dia., .500 in. depth		4270-12R
153	Conductive Connector Cap, Circular Size: .785 in. dia., .625 in. depth		4270-14Y
154	Conductive Connector Cap, Circular Size: .850 in. dia., .500 in. depth		4270-14R
155	Conductive Connector Cap, Circular Size: .893 in. dia., .625 in. depth		4270-16Y
156	Conductive Connector Cap, Circular Size: .973 in. dia., .500 in. depth		4270-16R
157	Conductive Connector Cap, Circular Size: 1.03 in. dia., .625 in. depth		4270-18Y
158	Conductive Connector Cap, Circular Size: 1.09 in. dia., .625 in. depth		4270-18R
159	Conductive Connector Cap, Circular Size: 1.125 in. dia., .560 in. depth		4270-19R
160	Conductive Connector Cap, Circular Size: 1.150 in. dia., .625 in. depth		4270-20Y
161	Conductive Connector Cap, Circular Size: 1.231 in. dia., .562 in. depth		4270-20R
162	Conductive Connector Cap, Circular Size: 1.270 in. dia., .625 in. depth		4270-22Y
163	Conductive Connector Cap, Circular Size: 1.340 in. dia., .562 in. depth		4270-22R
164	Conductive Connector Cap, Circular Size: 1.390 in. diam., .625 in. depth		4270-24Y
165	Conductive Connector Cap, Circular Size: 1.463 in. dia., .562 in. depth		4270-24R

Table 7-3. ESD Protective Equipment - Continued

Item No.	Item/Nomenclature	NSN	Part Number
166	Conductive Connector Cap, Circular Size: 1.540 in. dia., .625 in. depth		4270-25Y
167	Conductive Connector Cap, Circular Size: 1.645 in. dia., .625 in. depth		4270-28Y
168	Conductive Connector Cap, Circular Size: 1.715 in. dia., .562 in. depth		4270-28R
169	Conductive Connector Cap, Circular Size: 1.890 in. dia., .625 in. depth		4270-32Y
170	Conductive Connector Cap, Circular Size: 1.965 in. dia., .562 in. depth		4270-32R
171	Conductive Connector Cap, Circular Size: 2.140 in. dia., .625 in. depth		4270-36Y
172	Conductive Connector Cap, Circular Size: 2.215 in. dia., .600 in. depth		4270-36R
173	Conductive Connector Cap, Circular Size: 2.380 in. dia., .625 in. depth		4270-40Y
174	Conductive Connector Cap, Circular Size: 2.440 in. dia., .600 in. depth		4270-40R
175	Conductive Connector Cap, Circular Size: 2.630 in. dia., .625 in. depth		4270-44Y
176	Conductive Connector Cap, Circular Size: 2.720 in. dia., .600 in. depth		4270-44R
177	Conductive Connector Cap, Circular Size: 2.960 in. dia., .600 in. depth		4270-48R
178	Conductive "D" Connector Cap Size: .469 in. height, 2.112 in. width, .249 in depth [ref paragraph 7-5.d.(12)(d)]		4272-50P
179	Conductive "D" Connector Cap Size: .407 in. height, 2.049 in. width, .249 in. depth		4272-50S
180	Conductive "D" Connector Cap Size: .363 in. height, 2.216 in. width, .249 in. depth		4272-37P
181	Conductive "D" Connector Cap Size: .295 in. height, 2.143 in. width, .249 in. depth		4272-37S
182	Conductive "D" Connector Cap Size: .363 in. height, 1.568 in. width, .249 in. depth		4272-25P
183	Conductive "D" Connector Cap Size: .295 in. height, 1.495 in. width, .249 in. depth		4272-25S

Table 7-3. ESD Protective Equipment - Continued

Item No.	Item/Nomenclature	NSN	Part Number
184	Conductive "D" Connector Cap Size: .369 in. height, 1.040 in. width, .249 in. depth		4272-15P
185	Conductive "D" Connector Cap Size: .295 in. height, .955 in. width, .249 in. depth		4272-15S
186	Conductive "D" Connector Cap Size: .367 in. height, .682 in. width, .249 in. depth		4272-9P
187	Conductive "D" Connector Cap Size: .295 in. height, .627 in. width, .249 in. depth		4272-9S
188	Metal BNC Connector Cap (with chain)	5935-00-885-2264	
189	MIL-STD-1285 Sensitive Electronic Device Symbol [ref figure 7-8] Sizes: .25 in. x .25 in. .50 in. x .50 in. 1 in. x 1 in. 2 in. x 2 in. 6 in. x 6 in.	See Base Publications Distribution Office for Production of labels.	
190	MIL-STD 1686 ESD Caution Statement [ref 7-5.d.(13)(a)] Sizes: .25 in. x 1.75 in. 1 in. x 3.50 in. 2 in. x 7 in.	See Base Publications Distribute Office for Production of labels.	
191	MIL-STD-1285 Symbol/MIL-STD 1686 Caution Statement Combined [ref figure 7-9] Sizes: .50 in. x 1 in. 1 in. x 2 in. 2 in. x 4 in. 4 in. x 8 in.	See Base Publications Distribution Office for Production of labels.	
192	ESD Attention Label/No Further Packaging Required [ref figure 7-10] Sizes: .50 in. x 1 in. 1 in. x 2 in. 2 in. x 4 in. 4 in. x 8 in.	See Base Publications Distribution Office for Production of labels.	
193	Sensitive Electronic Device Label (For outermost bag or package) [ref figure 7-11] Size: 2 in. x .625 in. (Optical form 88)	7540-01-317-7371	
194	Sensitive Electronic Device Caution Label (Fast Pack, intermediate pack, exterior pack or shipping container [ref figure 7-12]		

Table 7-3. ESD Protective Equipment - Continued

Item No.	Item/Nomenclature	NSN	Part Number
	Sizes: 2 in. x 2 in. (optional form 87) 4 in. x 4 in. (optional form 87)A)	7540-01-109-8815 7540-01-110-4906	
195	Isopropyl Rubbing Alcohol 70% (ref para 7-5f)	6810-00-227-0410	
196	Thermoformable Conductive Sheet Material (for connector caps) 1/16 inch thick x 4ft x 8ft (ref para 7-5d(12)(d)		1801
197	Vacuum, Static Dissipative (ref para 7-5.f.(3)		Series 497
198	CWDE Battle Dress Overgarment (BDO) (Woodland Green)	8415-01-137-1700 through 8415-01-137-1707	
	BDO (Desert)	8415-01-327-5346 through 8415-01-327-5353	
	Chemical Protective Suit (Olive Drab)	8415-01-177-5007 8415-01-177-5008	
	Green Vinyl Overboot (GVO) or Black Vinyl Overboot (BVO)	8430-01-317-3374 through 8340-01-317-3385	
	Gloves - 7 mil	8415-01-138-2501 through 8415-01-138-2504	
	Gloves - 14 mil	8415-01-138-2497 through 8415-01-138-2500	
	Fishtail Boots	8415-01-118-8172 or 8415-01-021-5978	

NOTE

When NSNs are not available for the ESD Control products desired, per Table 7-3, ensure that a product specification is attached to the requisitioning documents and that it is called out therein as being a requirement of the item(s) being procured. See your facilities ESD Control Program Monitor to obtain these specifications. NSNs will be provided for all items listed in Table 7-3 when they become available.

e. Grounding. The ESD protective workstations, storage cabinets and flooring systems specified within paragraph 7-5.d. shall be properly grounded in accordance with the requirements outlined in this paragraph. Personnel safety is addressed to the extent that parameters and procedures specified in this section, if correctly implemented should minimize hazardous conditions for operators, technicians and other Air Force personnel. The ultimate responsibility for personnel safety must reside with the end user of this document.

(1) ESD Ground Measurement Reference Point. The equipment grounding conductor at the service entrance (Figure 7-14) shall be considered the ground reference point for ESD Control for powered indoor operations. Flightline maintenance operations shall utilize the ground terminations used to ground aircraft on the runways or taxi aprons as the ground reference point for ESD Control.

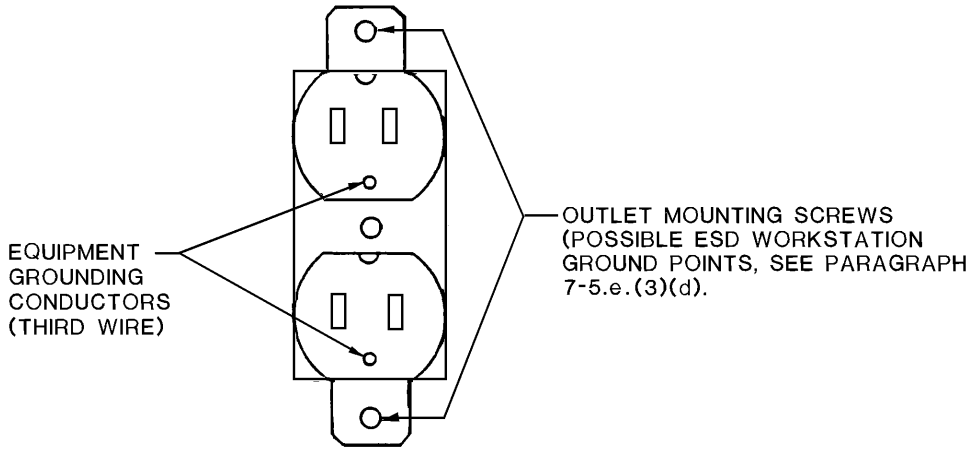

Figure 7-13. Typical Electrical AC Outlet

(2) Equipment Required For ESD Ground Integrity Checks. The test equipment required to do ESD ground integrity checks is specified in paragraphs 7-5.d.(11)(f) and (g). They include a D.C. Ohmmeter and Ground Impedance and Utility Wiring Verification Meter.

(3) ESD Control Workstation Grounding (Indoor Powered Operations). The ESD Control Workstations specified in paragraph 7-5.d.(1)(a), (b) and (c) all contain an ESD grounding conductor in the form of an insulated wire extending from the common point ground connector (see figures 7-3, 7-4 and 7-5). Figure 7-14 shows the wiring orientation of a typical service entrance. The third wire of a typical electrical AC outlet (shown as the load) represents a point electrically the same as the equipment grounding conductor at the service entrance. This equipment grounding conductor is brought to work areas via the third wire in power lines and receptacles. The following steps shall be taken to find an acceptable ground point for the ESD Control workstation(s) used in the area.

(a) Locate an electrical AC outlet that has an equipment grounding conductor (third wire). This does not include the use of outlets that are a part of or connected to the ESD Control workstation. Figure 7-13 shows a typical electrical AC outlet with an equipment grounding conductor. Isolated ground receptacles, typically having a triangular conductor on the plug, shall not be used.

(b) Using the Ground Impedance and Utility Wiring Verification Meter verify that the selected electrical AC outlet has the proper wiring orientation by checking:

* Hot, neutral and equipment ground wires are present and not reversed.

* Hot, neutral and equipment ground wires are not shorted.

* Hot, neutral and equipment ground wires are not open.

If the outlet is not wired correctly report the discrepancy to the responsible facility grounding official and area supervisor. Continue measuring outlets until one with the proper wiring orientation is found.

(c) When an acceptable outlet is found, measure the impedance between the equipment grounding conductor and the neutral conductor using the same meter. It shall be less than one ohm. If this impedance is greater than one ohm, report the findings to the responsible facility grounding official. If the ground impedance is less than one ohm, it can be concluded that the equipment grounding conductor in the outlet is an acceptable ground reference point for ESD control workstation grounding.

CAUTION

This test may deactivate any operational ground fault circuit interrupters that are connected in the same circuit.

(d) Any outlet mounting screw, metal raceway, metal conduit box, metal plug mold or metallic structure surrounding the electrical outlet

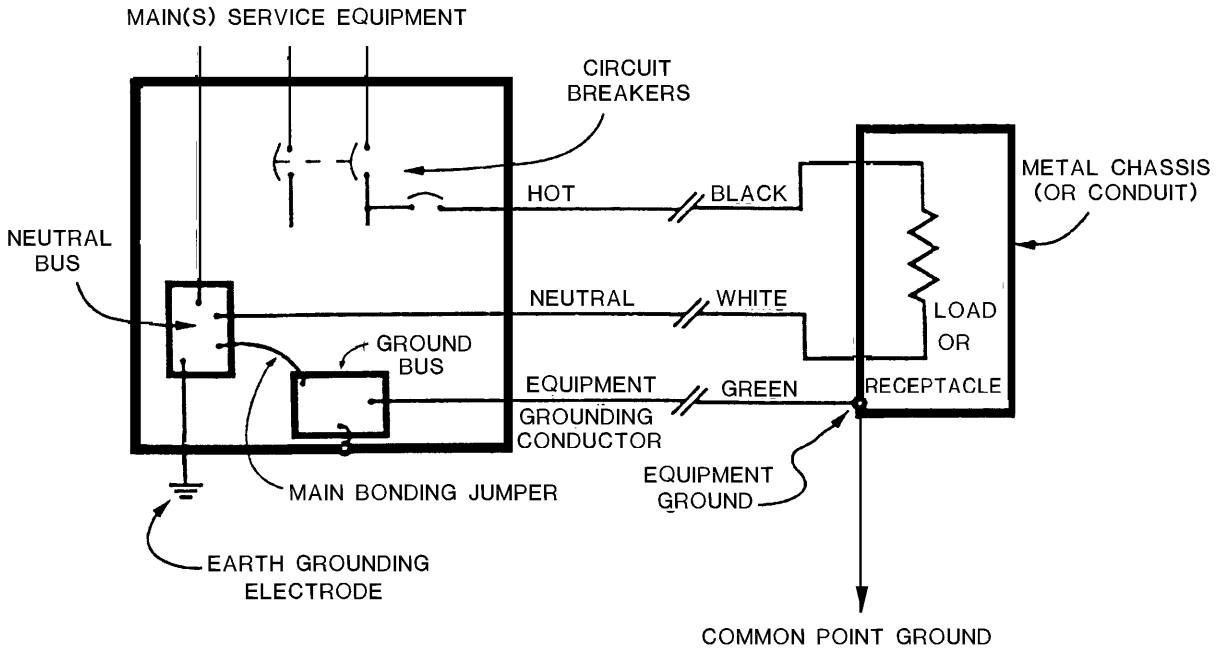

Figure 7-14. Typical Service Entrance

that can be electrically shown to be the same electrical potential as the acceptable equipment grounding conductor found in step 7-5.e.(3)(e) shall be used to ground an ESD Control workstation.

WARNING

DO NOT USE the round female equipment grounding conductor hole (third wire) to ground ESD control workstations.

To locate an acceptable grounding point: Measure the resistance between it and the equipment grounding conductor (third wire) of the electrical outlet using an ohmmeter. The resistance shall be less than 1 ohm. Mechanically fasten the ESD Control workstation ground wire to this point and verify the integrity of the connection. Do this by measuring the resistance between the countersink screw (for personal workstations) or the ground snap fastener on the detachable common point ground (for all other workstations) and the equipment grounding conductor (third wire). This resistance shall be either less than one ohm or 1×10^6 ohms ± 20%. A 1×10^6 ohm measurement means that a current limiting resistor exists within the workstation ground cord. Both resistances are acceptable for workstation grounding. Any value between or above these two values (with tolerances) are not acceptable, and the workstation ground wire must be replaced. The flow chart in Figure 7-15 summarizes these ESD Control Workstation grounding procedures.

(4) ESD Control Workstation Grounding (Building Steel). The ESD Control workstations specified in paragraphs 7-5.d.(1)(a), (b), and (c) can also be grounded by mechanically attaching their ground cords (see figures 7-3, 7-4, and 7-5) directly to building or structural steel when this ground point is electrically traceable to the equipment grounding conductor at the building service entrance in which the ESD Control workstation(s) are being installed. If power outlets exist in the area, the steps specified in paragraphs 7-5.e.(3) must be followed to ensure the wiring orientation and the ground impedance associated with the power outlet(s) are acceptable (see Figure 7-15, steps 2 and 3). This provides a reference within the work area against which the selected building or structural steel ground point can be verified. Use an ohmmeter to verify that the resistance between the grounding conductor (third wire) of the already tested outlet and the selected building or structural steel ground point is less than 1 ohm.

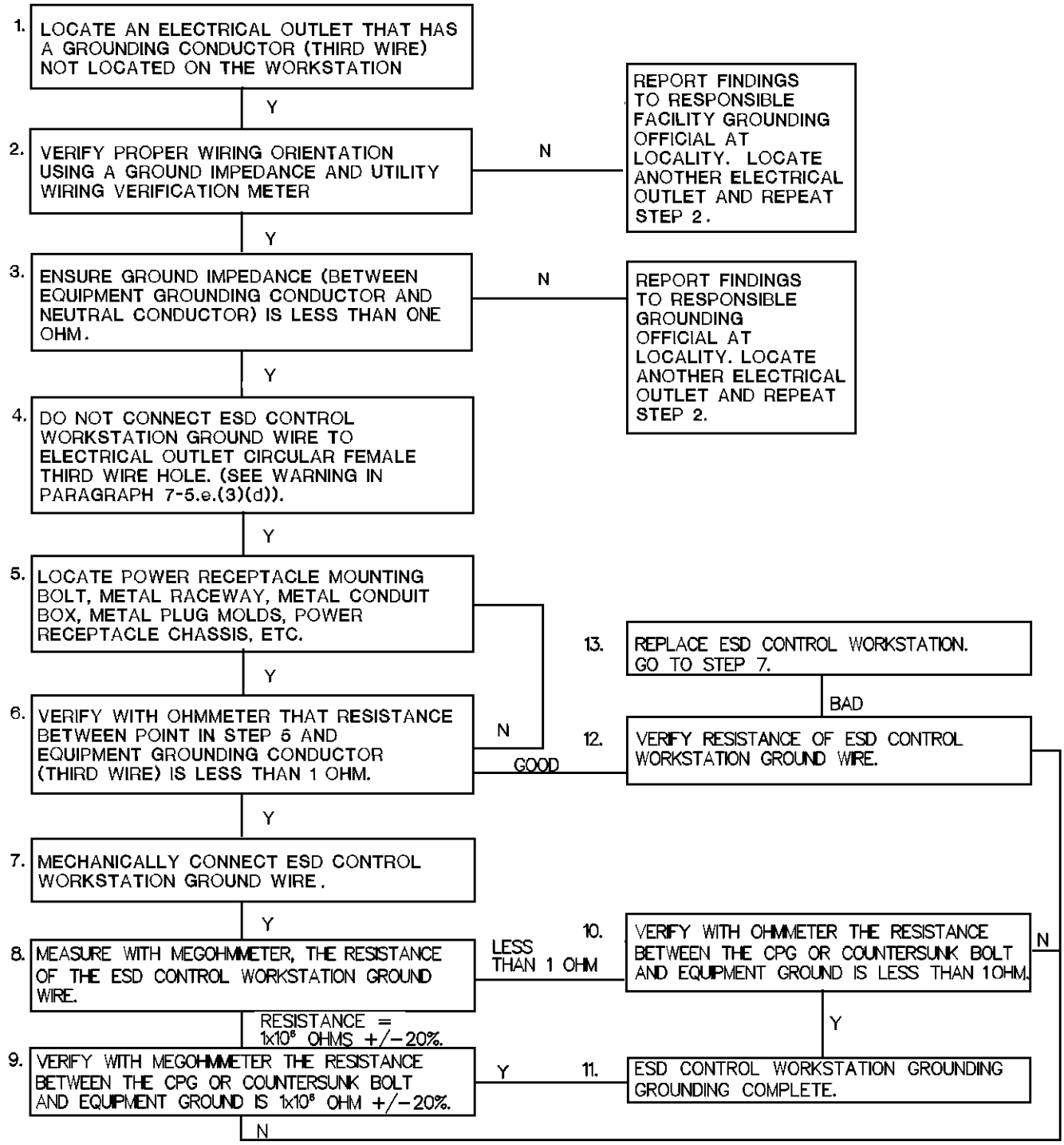

Figure 7-15. Flow Chart for ESD Control Workstation Grounding (Sheet 1 of 2)

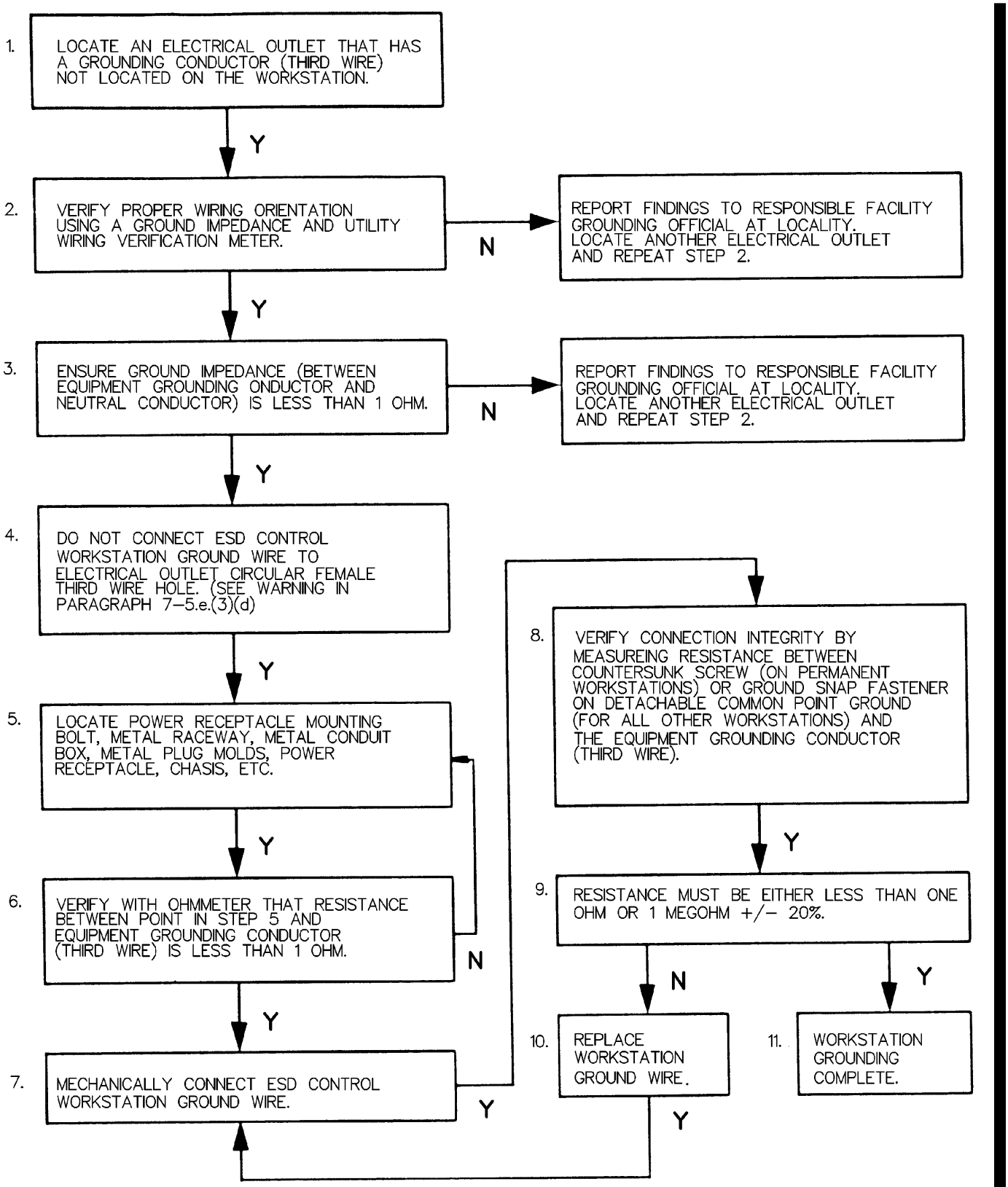

Figure 7-15. Flow Chart for ESD Control Workstation Grounding (Sheet 2 of 2)

If it is, then this point can be used to mechanically attach the ESD Control workstation.

(5) Storage Cabinets and Static Dissipative Floor Grounding. Cabinets and flooring shall be connected to verified ground points as specified for ESD Control workstations in paragraphs 7-5.e.(3) and (4). Each storage cabinet shall have an insulated ground wire mechanically attached to the cabinet and the grounding point in a manner similar to the ESD Control workstations mentioned previously. Floors shall have one ground wire per 10,000 square feet or part thereof with a minimum of 2 grounding points per floor.

(a) Grounding conductors for floors shall be:

Raised Floors: A No. 8 copper wire shall be bonded from a pedestal to the verified ground point. Appropriate oxide inhibitors shall be used between the base metal of the raised floor pedestal and the copper connection.

Tile or Poured-In-Place Floors: A 1 inch (minimum) wide copper strip shall be bonded from the epoxy used to secure the tile or poured material to a verified ground point. The grounding conductor shall be sufficiently thick to not break or tear easily.

(6) Portable ESD Control Workstation and Personnel Wrist Strap Grounding (Remote Indoor or Outdoor Operations). Portable ESD Control workstations or personnel wrist straps that are required for use shall be properly grounded. Since these workstations or wrist straps are used for remote handling of ESDS items (i.e. flightline or organizational level maintenance, airborne activities, remote test equipment), their grounding requirements are different. When the workstation or wrist strap is used during aircraft or missile organizational level maintenance, the grounding wire for the workstation or wrist strap shall be grounded (clipped) to a point on the aircraft/assembly that is electrically the same as the point to which the aircraft/assembly is grounded (i.e. runway, taxi apron, hanger, silo, test facility, etc.). A predesignated grounding point must be used or the integrity of the selected grounding point verified. When the portable ESD Control workstation is used to repair remote test equipment or any equipment items containing ESDS items per paragraph 7-4.a, it shall be grounded (clipped) to a point on the chassis of the equipment grounding conductor (third wire) of the power lines used to power the equipment. Verify that the resistance between the selected ESD portable workstation ground point on the equipment chassis and the grounding conductor (third wire) of the supplied power receptacle (outlet) is less than one ohm. Where site grounds are used in remote maintenance operations (missile LF, LCF, etc) this resistance shall be less than five ohms. If it is, the ESD Control portable workstation can be clipped to this point.

WARNING

The personnel wrist strap shall not be worn when working on energized parts, assemblies and equipment.

(7) Use of Ground Fault Interrupters (GFI) for ESD Control Purposes. The use of GFIs when grounding ESD Control workstations, storage cabinets or floor systems are not required. GFIs require adequate amounts of current to be activated and are not effective at controlling current available from the secondary winding of transformers or voltage increasing/decreasing components of equipment at the workstation. Static dissipative work surfaces such as those specified in this section for all ESD Control workstations and the corresponding personnel wrist straps contain large amounts of resistance either in the work surface material itself or in the form of a current limiting resistor which limits the current to levels below what is necessary to activate a GFI. The GFI is useful in applications where metallized conductive work surfaces are used around powered equipment that may short circuit and energize the entire work surface.

NOTE

USE OF A GFI SHOULD BE A SAFETY CONSIDERATION ANYTIME POWERED EQUIPMENT IS USED AND SHOULD NOT BE CONSTRUED AS AN ESD CONTROL REQUIREMENT.

(8) Personnel Safety. The safety requirements of MIL-STD-454, Requirement 1 shall be considered in the installation of ESD Control workstations, storage cabinets and floor systems to reduce the chance of electrical shock to personnel.

(a) Current rather than voltage is the most important variable in establishing the criterion for shock intensity. Three factors that determine the severity of electrical shock are: (1) magnitude of current flowing through the body; (2) path of current through the body; and (3) duration of time that the current flows through the body. The voltage necessary to produce a fatal current is dependent upon the resistance of the body, contact conditions, and the path through the body (see Table 7-4).

Table 7-4. Effects of Electrical Current on Humans (Ref MIL-STD-454)

Current Values (Milliamperes)		Effect
AC	DC	
25 Hz to 400 Hz		
0-1	0-4	Perception
1-4	4-15	Surprise
4-21	15-80	Reflex action
21-40	80-160	Muscular inhibition
40-100	160-300	Respiratory block
Over 100	Over 300	Usually fatal

(b) Sufficient current passing through any part of the body will cause severe burns and hemorrhages. However, relatively small currents can be lethal if the path includes a vital part of the body, such as the heart or lungs. Electrical burns are usually produced by heat from the arc which occurs when the body touches a high-voltage circuit. Electrical burns are also caused by passage of electrical current through the skin and tissue. AC currents of 4 to 21 milliamperes can cause reflex action. Although not electrically dangerous this could result in other safety hazards to people or equipment.

(9) Other Grounding Requirements. Other grounding and safety considerations that shall be implemented in ESD protected work areas are as follows:

(a) ESD Control workstations shall be tied independently to an acceptable ground point as determined per paragraph 7-5.e. Workstations shall not be tied together electrically in series.

(b) Resistance(s) to ground shall be high enough considering all parallel paths, to limit leakage current to personnel to 1 milliampere maximum based upon the highest voltage source

accessible by grounded personnel. Such voltage sources include power sources and test equipment.

(c) The ground connection of ESD Control workstations, storage cabinets and floor systems shall be of sufficient mechanical strength to minimize the possibility of inadvertent ground disconnections.

(d) The location of current limiting resistors in personnel wrist straps shall be as specified in paragraph 7-5.d.(2).

(e) Underground compressed air, dry nitrogen and vacuum air nozzles shall be grounded by bonding one end of No. 16 copper wire to the metallic or conductive nozzle, then bonding the other end to an acceptable ground point as outlined in paragraph 7-5.e.

f. Cleaning of ESDS Items.

(1) Exterior surfaces of assemblies or equipment containing ESDS devices may be cleaned in accordance with Section II, paragraph 2-8.

(2) Printed circuit boards/cards, wiring boards, modules and discrete parts sensitive to ESD shall be cleaned with brushes of the camel hair variety and a 70% isopropyl alcohol or greater cleaning solution with adequate electrical conductivity (1 x 109/ohm m or less) at room temperature. Connector pins tied to ESDS circuitry shall also be cleaned using these items.

CAUTION

The camel hair brush must be wet with a 70 % isopropyl alcohol or greater prior to and during cleaning of ESDS items. DO NOT use a dry brush. ESD damage to the item being cleaned may result.

WARNING

Isopropanol is flammable and toxic to eyes, skin, and respiratory tract. Avoid skin and eye contact. Good general ventilation is normally adequate. Keep away from open flames or other sources of ignition.

(3) Compressed air and dry nitrogen, without adequate filtering and usedto blow away or vacuum contaminants from ESDS items shall flow through grounded and metallized or conductive nozzles. Plastic or insulative nozzles have been shown to generate substantial electrostatic fields. For vacuuming ESD items (small operations) an acceptable static dissipative vacuum has been added to table 7-3.

7-6. OPERATING PROCEDURES: The following operating procedures apply to all military organizations that handle ESDS items. All personnel shall abide by these procedures.

a. All organizations shall designate a single point of contact (POC) for the subject of ESD control who can interpret the ESD Control requirements of this section of the TO and conduct work area ESD Control surveys per paragraph 7-7. The POC shall certify work areas through a certification evaluation. This evaluation will be the means by which the POC can assure that all work areas are in compliance with the requirements of the work area ESD Control survey. The appropriate certification documents shall be completed and either posted at the entrance to the work area or in a readily accessible ESD program file.

b. ESDS items shall only be handled outside of ESD protective packaging or non-protective packaging materials at ESD Control workstations that meet the requirements of this tech order [see paragraph 7-5.d.(1)]. When handling involves placement ESDS item in a remote test fixture, environmental chamber or other place where protective packaging cannot be used, a grounded personnel wrist strap shall be worn during installation and removal of the ESDS item. Locating a proper ground point for the wrist strap for these situations shall be accomplished in a similar fashion to that of a portable ESD Control workstation (see paragraph 7-5.e.(6)).

WARNING

The personnel wrist strap shall not be worn when working on energized parts, assemblies and equipment.

c. Portable static control workstations (paragraph 7-5.d.(1)(d)) shall be used (which includes the use of the personnel wrist strap) anytime handling and/ or maintenance of ESDS items (paragraph 7-4) is required away from the standard ESD Control workstation specified in paragraphs 7-5.d.(1)(a), (b), and (c).

d. Personnel shall check their individual wrist straps daily in accordance with paragraph 7-8.a. to ensure they are still functional. When conducting in-flight maintenance and missile maintenance where multiple day dispatching occurs, wrist

straps shall be tested prior to departure and upon return.

NOTE

Some persons with extremely dry skin may find that many wrist straps will not pass a daily functionality test. Hand or moisturizing creams that can be tolerated by these individuals from a health standpoint can be worn to obtain better electrical continuity between the wrist strap and the wrist.

e. ESDS items shall be transported and stored only in ESD protective packages and containers specified in paragraph 7-5.d.(12). For distribution personnel (receiving, packaging), all items with a type cargo code of "3"on the DD Form 1348-1 are ESDS and shall also be packaged in accordance with paragraph 7-5.d.(12). Marking of these packages shall be done in accordance with paragraph 7-5.d.(13)(c).

f. Static generating materials such as those listed in Table 7-1, that are not essential in conducting the work required at the ESD Control workstation, shall be removed entirely from the workstation.

g. All personnel involved with handling ESDS items shall be given ESD Awareness training that includes familiarization with this section of the TO.

h. All organizations shall conduct work area ESD Control surveys in accordance with paragraph 7-7 of this tech order. All work areas shall be surveyed to ensure that proper ESD Control products are acquired for each work area.

i. All personnel who handle, operate, remove or install ESDS items listed in paragraph 7-4a(3) must be properly grounded or bonded to the item. They must also ensure that conductive caps are placed on all item connectors when removing or installing these items from their next higher assembly. Either of the following two options are acceptable for proper personnel grounding and item capping during these operations:

OPTION 1. If cables are connected to or disconnected from these items, personnel shall touch (with bare skin) and maintain contact with a bare metal portion of the ESDS item's case or chassis and the cable connector backshell simultaneously while all cables are connected or disconnected. In addition, when two cables are connected, and at least one is connected to an ESDS item, personnel shall grasp the backshell of each cable prior to and during the connection process. Prior to removing or installing conductive caps, personnel shall touch (with bare skin) and maintain contact with a bare metal portion or the item's case or chassis. Contact shall be maintained at all times while conductive caps are being installed or removed or work is being accomplished on the ESDS item while connectors are unprotected. In addition, any cable left connected to an ESDS item must be capped in the same fashion.

OPTION 2. A ground wrist strap in accordance with paragraph 7-5e(6) shall be worn during all cable connecting and disconnecting operations and when conductive caps are installed or removed from these items.

DO NOT DISCARD the conductive caps. Save and reuse the caps on other assemblies.

WARNING

The personnel wrist strap shall not be worn when working on energized parts, assemblies and equipment.

j. Conductive or static shielding materials shall be used in constructing dust caps where dust caps are required for ESDS items instead of static generating materials such as those listed in Table 7-1.

k. Work areas considered temporary vs permanent that handle ESDS items shall be surveyed per paragraph 7-7 of this TO to determine what ESD Controls are necessary and are feasible for the temporary operation. Temporary areas consist of inside aircraft or vehicles, LFs, LCFs or areas where relocation commonly occurs.

l. Reports of Discrepancy (ROD), (SF 364) shall be completed each time ESDS items are received in packaging materials other than those specified in paragraph 7-5.d.(12) or improperly marked and not in conformance with paragraph 7-5.d.(13). These reports shall be completed and sent to the organization(s) from which the improperly packaged items were received regardless of whether the existing packaging requirements for the items are incorrect or whether the packaging policy of the organization sent the items improperly packaged is incorrect. In cases where improperly marked or packaged items are received by distribution from a commercial vendor/contractor source, the ROD shall be sent to the responsible contracting office for resolution. This effort will aid in ensuring that proper ESD Control packaging is specified during the acquisition process and used during transport of the items.

Figure 7-16. Typical ESD Protective Area Sign

m. All storage cabinets, parts bins, etc. that contain ESDS items shall be marked in accordance with paragraph 7-5.d.(14)(d) of this TO.

n. Efforts shall be made to avoid the use of Plexiglas or similar transparent, synthetic materials in the construction of cleaning, spraying, bead blasting or other booths where solvents or abrasives are propelled through gun-type nozzles where ESDS items are handled. This includes ensuring that all purchases of these types of booths include provisions for static dissipative, see-through surfaces in lieu of Plexiglas.

o. Personnel required to wear a chemical warfare defense ensemble (CWDE) when handling ESDS items shall only use CWDE apparel approved for ESD Control and listed in table 7-3.

p. All ESD Control workstation work surfaces, shelves, cabinets and storage units shall be tested annually in accordance with paragraph 7-8.a. Any work surface showing physical damage to the point where underlying layers are exposed shall be discarded and replaced.

q. ESD Control work surfaces shall be cleaned periodically as needed with a mild soap and water mixture. After drying, work surfaces shall be wiped with a 70 percent isopropanol-water solution using clean lint free cloth.

r. An ESD protective area sign(s) shall be placed at or near the entrance(s) to ESD Control work areas. In areas where transient personnel are not allowed (remote missile sites) or in areas that are outdoors (flightlines) the awareness sign is not necessary. The sign is intended primary for depots, PMELS, etc. Figure 7-16 shows what a typical awareness sign might look like.

s. Any wheeled metallic carts used in areas having ESD Control flooring shall have a metal drag chain installed on the bottom (riveted to the cart's metal chassis) to provide electrical continuity from the cart to the flooring.

t. Persons working at ESD Control workstations where circuit board, wiring board or module repair is done shall roll up their shirt sleeves above the elbow prior to and during repair, handling or inspection of these items.

u. Access to certified ESD Control work areas shall be limited to personnel who are properly trained and attired. Visitors shall be allowed in these areas only after being briefed on proper procedures to be followed while in the area and only when escorted by a trained employee. In areas with static dissipative flooring, visitors shall wear static dissipative shoe/footwear. The number of visitors in the area at one time shall be limited.

v. Static dissipative seating, shoes and flooring shall be performance tested annually in accordance with paragraphs 7-8.c, d, e and g.

w. Bench top ionizers shall be tested quarterly for performance in accordance with 7-8.f.

x. Grounds for ESD Control workstations and computer keyboard ground strips shall be verified when installed, relocated and annually thereafter in accordance with paragraph 7-5.e. If computer keyboard ground strips are cracked or broken they shall be replaced.

y. If the ESD Control products (paragraph 7-5.e.) required per the work area ESD Control survey (paragraph 7-7) and this TO conflict with specific item TOs, an AFTO Form 22 shall be submitted requesting the specific item TO be changed, via operational supplement to include the requirements of this TO.

z. Areas utilizing static dissipative flooring shall not wax or apply any topical coatings of any kind. Standard floor cleaning procedures shall be used to maintain these floors and care shall be taken to ensure that cleaning agents are completely removed after use (i.e. wet mopping).

aa. All solder guns or irons shall be tested quarterly to ensure that the tip is electrically connected to the equipment grounding conductor in the units plug. A periodic test procedure is included in paragraph 7-8k.

ab. Ensure all compressed air, dry nitrogen or vacuum nozzles used to clean ESDS items are conductive and properly grounded in accordance with paragraph 7-5.e.(9)(e). These grounds shall be checked annually in accordance with paragraph 7-8L.

7-7. WORK AREA ESD CONTROL SURVEYS

a. BACKGROUND. Work area ESD Control surveys will set up procedures to determine the level of ESD Control required in a given work area. This portion of this section provides requirements necessary to conduct such surveys.

b. GENERAL. Specific ESD Controls necessary in one area may not be the same as those required in another area. A work area ESD Control survey allows an ESD Control POC (see paragraph 7-6.a.) or team of experts to dictate the level of ESD Control essential in each area.

c. PERFORMING WORK AREA ESD CONTROL SURVEYS. The first step in an ESD Control Survey is to define the work area (flightline, hangar, avionics shop, depot repair room, etc.) Before beginning the work area survey, the surveyor shall determine the sensitivity level of the items handled in the work area. The surveyor can tap many sources in making this determination. He/she shall concentrate on the discrete parts handled in the work area first. A list of ESDS items should be in the applicable equipment TO. If the list is not in the TO, a list can be obtained from the assigned equipment specialist (see paragraph 7-4.a.(1)). If no such lists are available, use visual inspection of parts or bench stock and the guidelines given in paragraph 7-4. Distribution data bases can also be used. The sensitivity classification of the work area is based on the sensitivity of the discrete parts and not the end items. Stock classes called out in paragraph 7-4 are for discrete parts.

If the surveyor is performing a survey within a distribution, storage, or packaging area, the rules for determining whether items are handled as ESD sensitive are basically the same. Most discrete parts received, stored or handled within these areas have NSNs and can be easily referenced to paragraph 7-4.a.(1). For circuit boards handled in these areas it would be best to conduct the survey under the assumption that they are all sensitive to ESD. It follows then, that "black boxes", SRUs, LRUs, end items, etc. containing these boards are also ESDS and the area shall be equipped accordingly.

Next, the surveyor shall determine the levels or ESD protection and types of ESD Control products necessary for the work area. The surveyor shall determine what level of repair, test or storage is being done; however, regardless of the level assembly, individual parts determine ESD protection requirements.

d. ESD CONTROL PRODUCT REQUIREMENTS. Two basic rules are used in determining what and how many controls are required:

Rule 1. Handle all ESDS items at an approved static controlled workstation. This workstation shall be capable of controlling static on all things by grounding all conductors, including people. It shall also utilize bench top air ionization (when necessary per paragraph 7-7.d.(6)(b)) to neutralize static charge on all non-conductors.

Rule 2. Transport and store all static sensitive components, circuit boards, assemblies and systems in static shielding (Faraday Cage) packages or containers. A static shielding container is capable of protection of the inner contents against voltage fields as well as static discharges. In the case of whole systems containing ESDS items this static shield may be its metallic frame or shell as long as electrical leads to the outside world are properly capped with conductive materials.

The following ESD Control products are described for the surveyor's benefit. As stated, the surveyor will determine which of these items are necessary for the work area being surveyed. NSNs and/or part numbers for the ESD Control products specified herein are listed in Table 7-3. Only products qualified through the Air Force ESD Control Technology Center and listed in table 7-3 may be used in controlling ESD.

(1) STATIC CONTROL WORKSTATIONS. A basic static control workstation consists of three components; an adjustable wrist strap cuff and ground cord, a common point ground system, and

a static dissipative work surface. Paragraph 7-5.d.(1) provides a more detailed description of each workstation and the components thereof. Continuous workstation monitors are an optional requirement and may be used if the surveyor so desires.

The surveyor shall walk through and observe the work area with the help of the area supervisor or someone familiar with the operations within the area and determine the number of workstations where repair or handling of ESD Sensitive items occurs. He/she then decides which of the 4 types of workstations shall be used for the various handling or repair operation and shall annotate the number of each.

(2) TEST BENCHES. Test benches or areas where ESD Sensitive parts, circuit boards, assemblies and systems containing ESDS items are electrically tested for functionality will require ESD Control workstations. Benches used to perform go/no go testing only on shielded systems do not require ESD Control workstations. Grounding in accordance with paragraph 7-6.i. Must still be achieved when connecting/disconnecting and capping or uncapping systems. Work surfaces may be required to be odd shaped to conform to the shape of the working area associated with each unique test set. In these cases the surveyor can require that 40 foot lengths of cushioned static dissipative work surface material be purchased by the work area and cut to conform to the working area around each test station. For test stations where the item under test containing ESDS items is distant from the test console, there shall be a female wrist strap connector (banana jack), properly grounded, at the test location. It is common for technicians to open the item under test and remove faulty parts. The surveyor shall require that a wrist strap be worn when these operations take place. Bench top ionization is not required during a test operation.

(3) Wrist straps. The wrist straps may be required as a stand alone ESD Control item as described in paragraphs 7-6.i. and 7-7.d(2). The surveyor shall determine what operations within the area meet these requirements. Paragraph 7-5.d(2) provides a more detailed description of the components of the personnel wrist strap.

(4) UNIQUE SITUATIONS. At this point the surveyor has determined the number, location and type of ESD control workstations that are required for the work area for all test, repair, handling and storage operations. Unique situations may occur and should be handled as follows:

(a) Spray/cleaning booths and flush and conformal coating stations. Spray booths and flush and conformal coating stations used to clean or flush ESDS parts or assemblies shall have a female wrist strap connector (banana jack) connected in accordance with paragraph 7-5.e.(6) so that the operator can ground his/herself via a wrist strap when performing cleaning or coating operations. Nozzles used with compressed air or dry nitrogen shall conform to paragraph 7-5.f.(3).

(b) Ovens, temperature cycling stations. Ovens or temperature cycling stations used to cure coatings or temperature soak ESDS parts or assemblies shall be equipped with a properly grounded (see paragraph 7-5.e.(6)) female wrist strap connector (banana jack), to ground the operator via a wrist strap when installing or removing the ESD Sensitive items.

(c) Soldering Guns or Irons. All soldering guns or irons shall meet the requirements of Section 3, paragraph 3-4b of this TO when soldering on or around ESDS items.

(5) PACKAGING, MARKING AND STORAGE OF ESDS ITEMS.

(a) Whenever an ESD Sensitive item(s) is transported between workstations, work areas or between installations it shall be placed in properly closed static control packaging and marked accordingly. The surveyor shall determine what packaging and marking requirements are necessary for the area being surveyed based on requirements given in paragraph 7-5.d.(12) and (13) of this document.

(b) The surveyor shall require that any cabinet, bin or shelf used for storage of ESDS items within the work area be grounded. Remember, items within a complete faraday cage paragraph 7-4.b. are not ESDS. The surveyor can however, determine whether the packages containing the items will be opened regularly at the cabinet. In these cases cabinets and shelves must be grounded. He/she shall ensure that when the shelves of the cabinets or bins are grounded, the shelves, if painted, are electrically resistance checked to ensure the surface of each shelf is not above 1×10^9 ohms. If the resistance is higher than this value, the shelves must be fitted with static dissipative (1×10^6 to 1×10^9 ohms) or conductive (0 to 1×10^6 ohms) matting that is mechanically fastened to each shelf. The surveyor shall require that these storage cabinet alterations be made if necessary. If the area being surveyed is new, then new static dissipative storage cabinets with the above properties shall be procured. If multi-packs are stored in, and opened at these cabinets, a personnel wrist strap ground connection (verified per paragraph 7-5.e.) and proper packaging per paragraph 7-5.d.(12) shall be incorporated.

(c) The surveyor shall identify areas within the work area where discrete ESDS parts are stored and require that ESD Caution labels be applied to the front of each part compartment making them easily visible to personnel obtaining the parts. Information on these labels can be found in paragraph 7-5.d.(13)(d) of this TO.

(6) OTHER WORK AREA SURVEY REQUIREMENTS.

(a) WRIST STRAP TESTERS. The surveyor shall determine the number of testers required in a work area, and the location of those testers. The surveyor shall ensure that sufficient testers are available to perform the necessary daily checks of wrist strap functionality. The tester(s) shall be mounted in a visible location, approximately eye level, with instructions for use on a placard next to it. Wrist straps require daily functionality checks or as defined in paragraph 7-6.a(4).

(b) BENCH TOP IONIZATION. The surveyor shall determine whether SUPERSENSITIVE ESD items (see paragraph 7-4.c.) are removed or replaced on circuit boards, wiring boards or modules at the workstation. He/she must then determine whether the percentage of discreet parts handled that are SUPERSENITIVE is significant. That is, are more than 5% of the total ESDS parts handled in the work area SUPERSENITIVE. If so, a bench top air ionizer as described in paragraph 7-5.d.(4) shall be required at the workstation. The surveyor shall annotate the number and location of the required air ionizers and shall ensure that the required handling and reporting procedures are followed when using air ionizers.

NOTE

Handling of SUPERSENSITIVE ESDS items requires the use of bench top air ionization to help ensure that the workstation environment is as free of static charges is possible. Strict adherence to the other static control procedures outlined in the T.O. must also be followed, as there is still a finite amount of time (several seconds) needed for the ionizer to neutralize ALL static charges introduced to the workstation. Bench top ionizers ARE NOT required at benches where repair activities include only removal or replacement of printed circuit boards/cards, wiring boards or modules from the next higher assembly. Benches used strictly for electrical testing of circuit boards/cards, modules or wiring boards also DO NOT require bench top ionization.

NOTE

Bench top ionizers are used to neutralize static charge on JOB ESSENTIAL non-conducting items at a workstation handling SUPER SENSITIVE ESDS items. All other non-conductive materials shall be removed from the workstation. Job essential items made of vinyl, teflon, polyester or nylon shall be replaced with conductive substitutes where possible.

(c) HUMIDITY LEVELS. Although increased humidity levels in areas that handle ESDS items may decrease the amount of static charge found on personnel or items in the area, it may also give those in the work area a false sense of security that all ESD problems are gone. The fact is that these decreased static levels can still destroy the ESDS circuitry being handled. The surveyor shall handle the humidity issue as follows:

1 If steam generating equipment and air handlers already exist in the work area and levels of humidity between 40 and 60 percent can be achieved then it shall be required as part of the work area ESD Control survey.

2 If the work area is new with no capability to regulate humidity levels or is an older area that never had humidity regulating capabilities then the additional investment in such equipment is not necessary. The surveyor shall state that all other static control procedures and products required as part of the work area survey will adequately provide ESD protection.

3 If the work area is being constructed and it is known that SUPERSENSITIVE circuits (see paragraph 7-4.c.) such as VHSIC will be handled in the area, the investment shall then be made to regulate humidity levels in the room. Levels between 40% and 60% humidity shall be maintained. If this type of work area is being surveyed, the surveyor shall require that humidity be controlled.

(d) STATIC DISSIPATIVE GARMENTS. The surveyor shall require garments when surveying a clean room that utilizes clean room garments and handles ESDS items.

(e) STATIC DISSIPATIVE FLOOR SYSTEM. A static dissipative floor system (paragraph (7)), is an additional ESD Control requirement that shall be required by the work area surveyor only if one or more of the following conditions are met.

1 The work area in question is currently being constructed, will be handling ESDS items and ESD Control floor requirements can still be implemented into the purchase and facility design process.

2 The work area in question handles ESDS items and is replacing or plans to replace the existing flooring in the near future due to normal wear. ESD Control flooring shall be installed at that time.

3 The work area handles or works with SUPERSENSITIVE ESDS items and the percentage of SUPERSENSITIVE ESDS items to SENSITIVE ESDS items handled in the work area is greater than 5%. These items require the utmost in static protection due to their low static failure threshold voltages and flooring and footwear are required.

4 If the surveyed area requires static dissipative flooring per the guidelines mentioned above, then static dissipative footwear and seating shall be required (see paragraphs 7-5.d.(7)(a), (b), and (c)).

Finally if the area requires static dissipative flooring, and wheeled push carts are used in the area, the surveyor shall require the carts to have electrical continuity to the floor. A drag chain is required to be fastened to the base metal of the cart and long enough to touch the floor.

(f) CONDUCTIVE or STATIC DISSIPATIVE GLOVES/FINGER COTS. The surveyor shall require as part of the work area ESD Control survey that charge generating latex finger cots and gloves be removed from the work area and static protective ones be obtained if ESDS items are handled (see paragraph 7-5.d.(6)).

(g) COMPUTER KEYBOARD GROUND STRIPS. The surveyor shall require as part of the work area survey that computer keyboard ground strips be obtained and installed for any keyboard having the characteristics outlined in paragraph 7-5.d.(10). Note as outlined in paragraph 7-5.d.(10) that if the area is equipped with a static dissipative flooring system (paragraph 7-5.d.(7)) or if the computer is equipped with a personnel wrist strap, the keyboard strips are not required. Additionally, only computer equipment under which this TO is applicable fall within this requirement.

(h) WORK AREA ESD CONTROL SURVEY REPORTS. The numerous requirements for effective ESD Control for any work area as explained in this section of the TO shall be summarized in an official report that can be distributed to all management and area support personnel who will play a role in fulfilling the survey requirements. The surveyor shall reference this report when attempting to certify the work area in accordance with paragraph 7-6.a.

e. WORK AREA ESD CONTROL CHECKLIST.The following checklist can be used by the surveyor to aid in conducting work area ESD Control surveys.

(1) Is a work area ESD Control survey required? Requirement is established by the ESD Control POC or work area supervisor. Local policy may already dictate who determines whether a survey is required.

(a) Are ESDS items handled in the work area? Sources used to determine this are:

* Equipment TOs
* Correspondence from equipment specialist
* MIL-M-38535 Qualified Manufacturer's List, (QML-38535), Qualified Products List (QPL-19500) or base supply data system (Type Cargo Code "3" items)
* Inspection of parts or bench stock bins for items that are in the FSCs outlined in paragraph 7-4.a.(1).

(b) What is the sensitivity of the items handled in the work area? Use sources outlined in paragraph 7-7.e.(1)(a).

(2) Designate individuals to participate on the "survey team". As a minimum, it consists of the ESD POC and the work area supervisor.

(3) Define the work area. This may be a complete facility, a room, or a single workstation. It may also be defined by an operation (i.e. test, repair, storage, etc.) within a room or facility. This is determined by the survey team.

(4) Procedures for conducting a work area ESD Control survey.

(a) Minimum requirements of each of the following items in terms of amount and type shall be determined by the survey team.

* Workstation(s) (paragraphs 7-5.d.(1) and 7-7.d.(1)

* Wrist strap(s) (paragraph 7-5.d.(2))

* Common Point Ground System(s) (paragraph 7-5.d.(3))

* Continuous Workstation Monitor(s) (optional, see paragraph 7-5.d.(1)(a)

* Approved grounding point(s) (paragraph 7-5.e.) for CPGS(s) or Continuous Workstation Monitor(s).

* Wrist strap tester(s) (paragraph 7-7.d.(5)(b)

* Storage Cabinets, bins, shelving (paragraph 7-7.d.(5)(b)).

* Packaging and marking of ESDS items handled in the work area (paragraph 7-7.d. (5)).

* Restricted access (paragraph 7-6.u.)

* ESD protected area signs posted (paragraph 7-6.r.)

* Unnecessary static generators removed (paragraph 7-6.f.)

* Computer keyboard ground strips (paragraph 7-7.d.(6)(g)).

* Static dissipative gloves or finger cots (paragraph 7-7.d.(6)(f)).

* Soldering irons in accordance with paragraph 7-6.aa.

(b) Requirements based on sensitivity of items handled in the work area and facility features. The survey team shall determine which apply to the surveyed work area.

* Bench top ionizers (paragraph 7-7.d.(6)(b)).

* Static dissipative garments (paragraph 7-7.d.(6)(d)).

* Static dissipative floor system (paragraph 7-7.d.(6)(e)).

* Humidity control (paragraph 7-7.d.(6)(c)).

(5) Ensure steps are taken to update specific item technical orders to include ESD Control Procedures outlined in this T.O.

(6) A written "ESD Control Work Area Survey shall be distributed accordingly.

7-8. PERIODIC TESTING OF ESD CONTROL PRODUCTS. Periodic testing of items or materials used to control ESD is required per paragraph 7-6 in the time intervals specified.

a. Work Surface Test Procedures.

(1) Equipment Required. The test equipment required to do work surface testing is specified in paragraph 7-5.d.(11)(e).

(2) The work surface shall be testing in it's existing environment.

(3) All resistance measurements shall be taken 5 seconds after applying test voltage (100 volts).

(4) Connect the positive lead from the megohmmeter to one of the five lb. electrodes and the negative lead to the common point ground. Place the electrode near the rear edge of the work surface and approximately 36″ from the common point ground. Apply test voltage of 100 volts. Take reading and record. Repeat procedure placing the electrode in the center of the work surface and again near the forward edge of the work surface. Total resistance from top of work surface to ground point for each measurement shall be between 1×10^{6} and 1×10^{9} ohms.

(5) If the measurements taken do not fall within the specified range, clean the component being tested with a 70 percent isopropanol-water solution using a clean lint free cloth. Repeat step 7-8.a.(4).

(6) If the measurements taken still do not fall within the specified range the work surface shall be discarded and replaced.

b. Storage Cabinet and Shelf Test Procedures.

(1) Test Equipment Required. The test equipment required to test shelves, cabinets, and storage units is specified in paragraph 7-5.d.(11)(e).

(2) All shelves, cabinets, and storage units shall be tested in their existing environment.

(3) All resistance measurements shall be taken 5 seconds after applying test voltage (100 volts).

(4) Connect the positive lead from the megohmmeter to one of the five lb. electrodes and the negative lead to the ground point. For components mounted on a work station, the negative lead will be the common point ground embedded in the work surface. The negative lead connection for shelves and cabinets not on static dissipative floors, shall be to the verified ground point. For shelves and cabinets (not workstations) mounted on static dissipative floors the negative terminal shall be a 5 lb. electrode placed on the floor. Place the positive lead on a shelf/drawer and apply 100 volts. Three measurements shall be taken and averaged per drawer/shelf and recorded. This average resistance from the surface of the component being tested to the ground point shall be between 1×10^{6} and 1×10^{9} ohms.

(5) If the measurements taken do not fall within the specified range, clean the component being tested with a 70 percent isopropanol-water solution using a clean lint free cloth. Repeat paragraph 7-8.b.(4).

(6) If the measurements taken still do not fall within the specified range the components shall be discarded or covered with a material that meets the prescribed resistance.

c. Flooring Test Procedures.

(1) Test Equipment Required. The test equipment required for testing installed flooring is specified in paragraph 7-5.d.(11)(e).

(2) Flooring shall be tested in it's existing environment and normal state of cleanliness.

(3) All resistance measurements shall be taken 5 seconds after applying test voltage (100 volts).

(4) The installed floor shall be subjected to surface to ground resistance measurements using the specified megohmmeter and electrode. The applied open circuit test voltage shall be 100 volts for each measurement.

(5) RAISED FLOORS: Resistance measurements are made by connecting the positive lead from the megohmmeter to the electrode and connecting the negative lead to the ground point. Remove a panel from the floor and connect the negative lead to an installed pedestal beneath the floor. Apply the test voltage (100 volts). Take the measurement and record. Repeat for each measurement taken.

(a) A total of 16 equally spaced resistance measurements shall be taken for every 10,000 square foot area of flooring. For floors with less than 10,000 square feet one resistance measurement shall be taken for each 400 square feet of flooring (equally spaced). The average of the total surface to ground resistance measurements shall be between 1×10^6 and 1×10^9 ohms with no individual measurement being above 5×10^9 or below 1×10^6 ohms.

(b) If the floor fails to meet these specifications the floor shall be thoroughly cleaned in accordance with the manufacturers recommendations and retested as per paragraph 7-8.c.(6) and (7).

(c) If the floor still fails to meet these specifications, verify the calibration of the megohmmeter and retrieve the initial installed floor test results. Compare test results and determine if the readings are higher or lower than the initial readings. If higher, this may suggest that the floor has been waxed or coated. Take steps to determine if this is the case. If so, the floor must be stripped and recleaned before retesting. If the readings are lower, a coating still may have been added, but with conductive properties. Again, stripping and recleaning will be necessary. These procedures should bring the floor within the specified resistance range.

(6) OTHER FLOORS: The resistance measurement procedure is the same as for raised floors with the exception that the negative lead from the ohmmeter is connected to a point electrically the same as one of the acceptable points at which the floor is grounded. The number of test points, specified resistance range and retest processes are as specified in paragraphs 7-8.d.(1), (2) and (3).

d. Wrist Strap Test Procedures.

(1) Test Equipment Required. Test equipment required for testing wrist straps is a wrist strap tester as specified in paragraph 7-5.d.(11)(b).

(2) The wrist strap shall be tested while being worn.

(3) Insert wrist strap banana plug into the banana jack on the wrist strap tester. With the hand opposite that on which the wrist strap is being worn, press the metal contact plate until either the green or red pass/fail light is illuminated. Ensure at the time that the battery check light illuminates. If it does not, check the batteries. If it is, then observe the pass/fail light.

(4) If the green light illuminates, the wrist strap and cord are both good, having a resistance of less than 10 megohms and greater than 750k ohms.

(5) If red light illuminates, disconnect the wrist strap cuff from the cord and connect the cuff end of the cord to the wrist fastener connection on the tester. Press the contact with a bare hand. If the green light illuminates the cord is good, having a resistance of 1×10^6 ohms ± 20%. Discard the wrist strap cuff. If red light illuminates, discard the cord.

(6) Replace the wrist strap cuff or cord accordingly and repeat steps 7-8.d.(3), (4) and (5).

e. Footwear Test Procedures.

(1) Shoes will be replaced on an as needed basis determined by wear and condition of shoe in general.

(2) Shoes shall be lab tested by random sampled lots annually. The test method and resistance specification can be obtained from the ESD

Control Technology Center at Newark AFB, DSN 346-7383.

f. Test Procedures for Bench Top Electrical Ionizers.

(1) Test Equipment Required. the test equipment required for testing bench top electrical ionizers is specified in paragraph 7-5.d.(11)(h). A standard measuring tape (minimum 6 ft.) and air velocity measuring meter (ft/min) are also required.

(2) The ionizer shall be tested in its' existing environment with the heater off, if so equipped. The ionizer shall be tested with filters in place, if so equipped, and at a maximum air flow rate of 550 FPM. The air velocity shall be measured and recorded in the test results.

(3) Discharge Time Test.

(a) Place the charge plate monitor directly in front of the ionizer with the plate parallel to the front face of the ionizer at a distance of one foot.

(b) Turn the ionizer on, wait 30 seconds, charge the plate to +1000 volts and allow it to discharge to +100 volts. The charge plate monitor will measure the time it takes to discharge. Record the discharge time. Repeat procedure for -1000 volts. The discharge time for both the + and - initial plate voltages shall be less than two (2) seconds.

(c) Repeat paragraphs 7-8.f.(3)(a) and (b) for plate to ionizer distances of 2, 3, and 4 feet. The discharge times for these distances shall be 3 seconds, 5 seconds, and 7 seconds respectively.

(d) If the voltages do not discharge in the specified time clean and balance the ionizer in accordance with the manufacturers instructions.

(e) Repeat steps 7-8.f.(3)(a) and (b).

(f) If the voltages still do not discharge in the specified time limit the ionizer shall be discarded.

(4) Offset Voltage Test.

(a) Place the charge plate monitor in front of the ionizer and oriented as specified in paragraph 7-8.f.(3)(a). The distance between the plate and the ionizer shall be six (6) inches.

(b) The plate shall be momentarily grounded to remove any residual charge and to verify zero of the monitor's circuitry.

(c) Turn the ionizer on and allow it to operate for one (1) minute, or as necessary to allow reading to stabilize (maximum five (5) minutes). Record the plate voltage. The voltage shall not exceed 20 volts.

(d) If the measurement exceeds the maximum of 20 volts, follow manufacturers instructions for ion balancing. If the unit is self balancing or has no ion balancing ability the unit shall be discarded.

(e) After balancing, repeat steps 7-8.f.(4)(a), (b), and (c).

(f) If the measurement still exceeds the maximum of 20 volts the unit shall be discarded.

g. Seating Test Procedures.

(1) Equipment required. The equipment required for testing seating is as specified in paragraph 7-5.d.(11)(e). A non-anodizing, 3″x 6″, flat metal sheet (min 1/16 inch thick) is also required as a test electrode.

(2) Seating shall be tested in it's existing environment. Do not clean the chair. Remove only those items that might interfere with the test.

(3) All resistance measurements shall be taken five (5) seconds after applying test voltage (100 volts).

(4) The resistance of each tested seat shall be between $1x10^6$ and $1x10^9$ ohms.

(5) Place one caster on top of the 3″ x 6″ electrode assuring that the electrode is clean (no oxidation). Place one of the 5 lb. electrodes from the test kit on the 3″ x 6″ electrode.

(6) Place the other 5 lb. electrode from the test kit in the middle of the seat. Assure that the contact surface of the electrode is clean (no oxidation).

(7) Connect the positive lead from the megohmmeter to the 5 lb. electrode that is on the seat. Connect the negative lead from the megohmmeter to the 5 lb. electrode that is on the 3″ x 6 ″electrode.

(8) Apply test voltage and record the resistance value.

(9) Repeat steps 7-8.g(5), (6), (7) and (8) for all casters.

(10) If the measurement does not fall within the specified range, disconnect the negative lead from the 5 lb. electrode on the 36 X 36 inch electrode and connect it directly to a metal point on the seat base. Reapply the test voltage and record the resistance value.

(11) If the measurement in step 7-8.g.(9) falls within the specified range, clean the casters

of the seat thoroughly with a 70 percent isopropanol-water solution using a clean lint free cloth. Allow to air dry.

(12) Repeat steps 7-8.g.(5), (6), (7), and (8). If the reading is still outside the specified range, replace the casters.

(13) If the seat still does not meet the resistance requirement after changing the casters, replace the seat.

h. Shielding Bag Test Procedures. A visual inspection of shielding bags will be accomplished prior to each use. If the bag is torn or ripped it will be discarded.

i. Conductive/Static Dissipative Finger Cots and Gloves. No reuse is allowed. Discard after each use.

j. Workstation Grounding Test Procedures. Workstation grounding shall be tested in accordance with the procedures outlined in paragraph 7-5.e.

k. Solder Gun or Iron Test Procedures.

(1) Equipment required. The equipment required for testing solder guns or irons is as specified in paragraph 7-5.d(11)(f).

(2) The solder gun or iron shall be tested in its existing environment.

(3) Connect or contact leads of the ohmmeter to the tip of the solder gun/iron and the equipment grounding conductor (round) or third wire of the items plug.

(4) The measure resistance shall be less than 1,000 ohms.

(5) If the measurement exceeds 1,000 ohms, replace the solder iron/gun tip and remeasure.

l. Compressed Air, Dry Nitrogen and Vacuum Nozzle Ground Test Procedures.

(1) Equipment required. The equipment required for testing the nozzle is as specified in paragraph 7-5.d(11)(f).

(2) Connect or contact the positive lead of the ohmmeter to the nozzle tip and the negative lead to an equipment ground conductor (third wire) as defined in paragraph 7-5.e. for a nearby ESD Control Workstation or as accessible.

(3) The measured resistance shall be less than 1×10^6 ohms.

Package Marking _____
Hardware Marking _____
Storage Cabinet Marking _____

FACILITY/CLOTHING
Approved Facility Grounds _____

Humidity Control _____

Wrist Strap Testers _____

Static Dissipative Garments _____

Static Dissipative Gloves/
Finger Cots _____

Grounded and Properly
Shelved Storage Cabinets _____

Restricted Access Provisions _____

ESD Protected Area Signs _____

Unnecessary Static Generators
Removed _____

(6) List in the table below the number, type and location of the ESD Control Workstations required to accomplish established work loads.

OPERATION	NUMBER, TYPE & LOCATION OF STATIONS
(1) Repair (remove/replace components)	
(2) Test (testing and trouble shooting)	
(3) Handling (other than test or repair)	
(4) Storage	
(5) Unique Operations	
Spray and Flush	
Conformal coating (remove/replace)	
Temperature cycling, ovens	
Other	

(7) Ensure steps are taken to update specific item technical orders to include ESD Control Procedures outlined in this T.O.

(8) A written "ESD Control Work Area Survey Report" shall be distributed accordingly.

7-8. PERIODIC TESTING. Periodic testing of items or materials used to control ESD is required per paragraph 7-6 in the time intervals specified.

a. Equipment Required. Equipment required to accomplish these tests is identified in 7-5.d.(11).

b. Work Surface Test Procedures.

(1) Equipment Required. The test equipment required to do work surface testing is specified in paragraph 7-5.d.(11)(e).

(2) The work surface shall be testing in it's existing environment.

(3) All resistance measurements shall be taken 5 seconds after applying test voltage (100 volts).

(4) Connect the positive lead from the megohmmeter to one of the five lb. electrodes and the negative lead to the common point ground. Place the electrode near the rear edge of the work surface and approximately 36″ from the common

point ground. Apply test voltage of 100 volts. Take reading and record. Repeat procedure placing the electrode in the center of the work surface and again near the forward edge of the work surface. Total resistance from top of work surface to ground point for each measurement shall be between 1×10^6 and 1×10^9 ohms.

(5) If the measurements taken do not fall within the specified range, clean the component being tested with a 70 percent isopropanol-water solution using a clean lint free cloth. Repeat step 7-8.b.(4).

(6) If the measurements taken still do not fall within the specified range the work surface shall be discarded and replaced.

c. Storage Cabinet and Shelve Test Procedures.

(1) Test Equipment Required. The test equipment required to test shelves, cabinets, and storage units is specified in paragraph 7-5.d.(11)(e).

(2) All shelves, cabinets, and storage units shall be tested in their existing environment.

(3) All resistance measurements shall be taken 5 seconds after applying test voltage (100 volts).

(4) Connect the positive lead from the megohmmeter to one of the five lb. electrodes and the negative lead to the ground point. For components mounted on a work station, the negative lead will be the common point ground embedded in the work surface. The negative lead connection for shelves and cabinets not on static dissipative floors, shall be to the verified ground point. For shelves and cabinets (not workstations) mounted on static dissipative floors the negative terminal shall be a 5 lb. electrode placed on the floor. Place the positive lead on a shelf/drawer and apply 100 volts. Three measurements shall be taken and averaged per drawer/shelf and recorded. This average resistance from the surface of the component being tested to the ground point shall be between 1×10^6 and 1×10^9 ohms.

(5) If the measurements taken do not fall within the specified range, clean the component being tested with a 70 percent isopropanol-water solution using a clean lint free cloth. Repeat paragraph 7-8.c.(4).

(6) If the measurements taken still do not fall within the specified range the components shall be discarded or covered with a material that meets the prescribed resistance.

d. Flooring Test Procedures.

(1) Test Equipment Required. The test equipment required for testing installed flooring is specified in paragraph 7-5.d.(11)(e).

(2) Flooring shall be tested in it's existing environment and normal state of cleanliness.

(3) All resistance measurements shall be taken 5 seconds after applying test voltage (100 volts).

(4) The installed floor shall be subjected to surface to ground resistance measurements using the specified megohmmeter and electrode. The applied open circuit test voltage shall be 100 volts for each measurement.

(5) RAISED FLOORS: Resistance measurements are made by connecting the positive lead from the megohmmeter to the electrode and connecting the negative lead to the ground point. Remove a panel from the floor and connect the negative lead to an installed pedestal beneath the floor. Apply the test voltage (100 volts). Take the measurement and record. Repeat for each measurement taken.

(a) A total of 16 equally spaced resistance measurements shall be taken for every 10,000 square foot area of flooring. For floors with less than 10,000 square feet one resistance measurement shall be taken for each 400 square feet of flooring (equally spaced). The average of the total surface to ground resistance measurements shall be between 1×10^6 and 1×10^9 ohms with no individual measurement being above 5×10^9 or below 1×10^6 ohms.

(b) If the floor fails to meet these specifications the floor shall be thoroughly cleaned in accordance with the manufacturers recommendations and retested as per paragraph 7-8.d.(6) and (7).

(c) If the floor still fails to meet these specifications, verify the calibration of the megohmmeter and retrieve the initial installed floor test results. Compare test results and determine if the readings are higher or lower than the initial readings. If higher, this may suggest that the floor has been waxed or coated. Take steps to determine if this is the case. If so, the floor must be stripped and recleaned before retesting. If the readings are lower, a coating still may have been added, but with conductive properties. Again, stripping and recleaning will be necessary. These procedures should bring the floor within the specified resistance range.

(6) OTHER FLOORS: The resistance measurement procedure is the same as for raised floors with the exception that the negative lead

from the ohmmeter is connected to a point electrically the same as one of the acceptable points at which the floor is grounded. The number of test points, specified resistance range and retest processes are as specified in paragraphs 7-8.e.(1), (2) and (3).

e. Wrist Strap Test Procedures.

(1) Test Equipment Required. Test equipment required for testing wrist straps is a wrist strap tester as specified in paragraph 7-5.d.(11)(b).

(2) The wrist strap shall be tested in it's existing environment while being worn.

(3) Insert wrist strap banana plug into the banana jack on the wrist strap tester. With the hand opposite that on which the wrist strap is being worn, press the metal contact plate until either the green or red pass/fail light is illuminated. Ensure at the time that the battery check light illuminates. If it does not, check the batteries. If it is, then observe the pass/fail light.

(4) If the green light illuminates, the wrist strap and cord are both good.

(5) If red light illuminates, disconnect the wrist strap cuff from the cord and connect the cuff end of the cord to the wrist fastener connection on the tester. Press the contact with a bare hand. If the green light illuminates the cord is good. Discard the wrist strap cuff. If red light illuminates, discard the cord.

(6) Replace the wrist strap cuff or cord accordingly and repeat steps 7-8.e.(3), (4) and (5).

f. Test Procedures for Shoes.

(1) Shoes will be replaced on an as needed basis determined by wear and condition of shoe in general.

(2) Shoes shall be lab tested by random sampled lots annually. The test method and resistance specification can be obtained from the ESD Control Technology Center at Newark AFB, DSN 346-7383.

g. Test Procedures for Bench Top Electrical Ionizers.

(1) Test Equipment Required. the test equipment required for testing bench top electrical ionizers is specified in paragraph 7-5.d.(11)(h). A standard measuring tape (minimum 6 ft.) and air velocity measuring meter (ft/min) are also required.

(2) The ionizer shall be tested in its' existing environment with the heater off, if so equipped. The ionizer shall be tested with filters in place, if so equipped, and at a maximum air flow rate of 550 FPM. The air velocity shall be measured and recorded in the test results.

(3) Discharge Time Test.

(a) Place the charge plate monitor directly in front of the ionizer with the plate parallel to the front face of the ionizer at a distance of one foot.

(b) Turn the ionizer on, wait 30 seconds, charge the plate to +1000 volts and allow it to discharge to +100 volts. The charge plate monitor will measure the time it takes to discharge. Record the discharge time. Repeat procedure for -1000 volts. The discharge time for both the + and - initial plate voltages shall be less than two (2) seconds.

(c) Repeat paragraphs 7-8.g.(3)(a) and (b) for plate to ionizer distances of 2, 3, and 4 feet. The discharge times for these distances shall be 3 seconds, 5 seconds, and 7 seconds respectively.

(d) If the voltages do not discharge in the specified time clean and balance the ionizer in accordance with the manufacturers instructions.

(e) Repeat steps 7-8.g.(3)(a) and (b).

(f) If the voltages still do not discharge in the specified time limit the ionizer shall be discarded.

(4) Offset Voltage Test.

(a) Place the charge plate monitor in front of the ionizer and oriented as specified in paragraph 7-8.g.(3)(a). The distance between the plate and the ionizer shall be six (6) inches.

(b) The plate shall be momentarily grounded to remove any residual charge and to verify zero of the monitor's circuitry.

(c) Turn the ionizer on and allow it to operate for one (1) minute, or as necessary to allow reading to stabilize (maximum five (5) minutes). Record the plate voltage. The voltage shall not exceed 20 volts.

(d) If the measurement exceeds the maximum of 20 volts, follow manufacturers instructions for ion balancing. If the unit is self balancing or has no ion balancing ability the unit shall be discarded.

(e) After balancing, repeat steps 7-8.g.(4)(a), (b), and (c).

(f) If the measurement still exceeds the maximum of 20 volts the unit shall be discarded.

h. Test Procedures For Seating.

(1) Equipment required. The equipment required for testing seating is as specified in paragraph 7-5.d.(11)(e). A non-anodizing, 36 X 36 inch, flat metal sheet (min 1/16 inch thick) is also required as a test electrode.

(2) Seating shall be tested in it's existing environment. Do not clean the chair. Remove only those items that might interfere with the test.

(3) All resistance measurements shall be taken five (5) seconds after applying test voltage (100 volts).

(4) The resistance of each tested seat shall be between $1x10^6$ and $1x10^9$ ohms.

(5) Place the seat on top of the 36 X 36 inch electrode assuring that the electrode is clean (no oxidation) and all casters of the seat are on the electrode. Place one of the 5 lb. electrodes from the test kit on the 36 X 36 inch electrode between two seat casters.

(6) Place the other 5 lb. electrode from the test kit in the middle of the seat. Assure that the contact surface of the electrode is clean (no oxidation).

(7) Connect the positive lead from the megohmmeter to the 5 lb. electrode that is on the seat. Connect the negative lead from the megohmmeter to the 5 lb. electrode that is on the 36“ x 36”electrode.

(8) Apply test voltage and record the resistance value.

(9) If the measurement does not fall within the specified range, disconnect the negative lead from the 5 lb. electrode on the 36 X 36 inch electrode and connect it directly to a metal point on the seat base. Reapply the test voltage and record the resistance value.

(10) If the measurement in step 7-8.h.(9) falls within the specified range, clean the casters of the seat thoroughly with a 70 percent isopropanol-water solution using a clean lint free cloth. Allow to air dry.

(11) Repeat steps 7-8.h.(5), (6), (7), and (8). If the reading is still outside the specified range, replace the casters.

(12) If the seat still does not meet the resistance requirement after changing the casters, replace the seat.

i. Test Procedures For Shielding Bags. A visual inspection of shielding bags will be accomplished prior to each use. If the bag is torn or ripped it will be discarded.

j. Conductive/Static Dissipative Finger Cots and Gloves. No reuse is allowed. Discard after each use.